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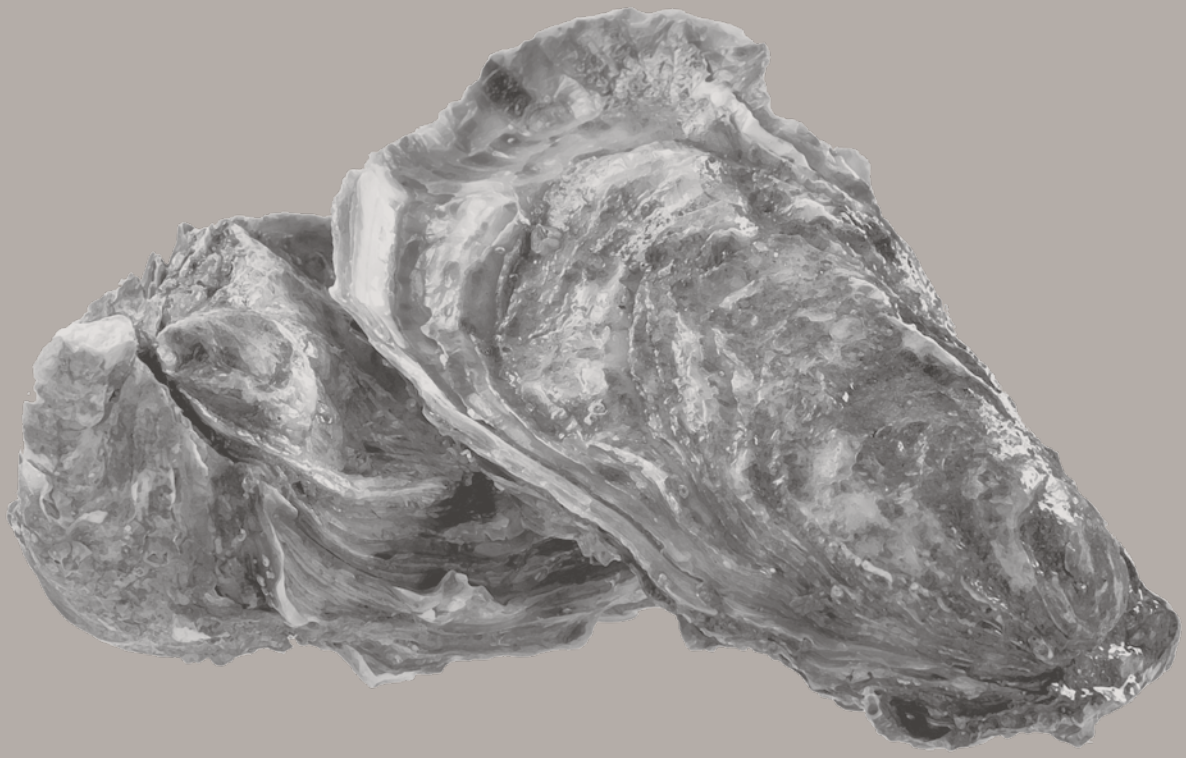

LOUISIANA OYSTER

2018 Stock Assessment Report of the Public Oyster Seed Grounds and Reservations of Louisiana

Oyster Data Report Series No. 24

LOUISIANA DEPARTMENT OF WILDLIFE & FISHERIES

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Introduction

Louisiana's vast coastal wetlands provide ample habitat where Eastern oysters (*Crassostrea virginica*) thrive under a variety of environmental conditions. Louisiana's Eastern oyster resource is one of the largest oyster resources in the nation, supporting one of state's largest and most valuable fisheries and providing important ecological services to the state. The Louisiana Department of Wildlife and Fisheries (LDWF) is charged with managing the state's oyster resource by closely monitoring the size and health of oyster populations on nearly 1.7 million acres of public oyster areas (*Figure 1*) as well as setting oyster seasons, monitoring harvest levels, and enhancing habitat (e.g. cultch planting, reef building, etc.).

The oyster industry has historically used Louisiana's public oyster areas as a source of seed oysters (less than 3 inches shell height) to transplant to private oyster leases and grow out to market-size. In Louisiana, there are approximately 404,000 acres of private oyster leases that are managed by leaseholders. The public oyster areas also yield a supply of market-size oysters (greater than or equal to 3 inches shell height), which may be taken directly to market. Louisiana leads the nation in oyster production largely due to this public/private oyster production system. Annual dockside sales have reached as much as $84 million in recent years (most recent data from the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).

LDWF manages public oyster seed areas to balance the economic opportunity of the fishery with the biological sustainability of the resource. Management depends on obtaining the best fishery dependent and independent data available through monitoring harvest and resource availability throughout the oyster season and performing yearly stock assessments. The annual individual Coastal Study Area (CSA) oyster stock assessment reports help fulfill these data needs as they provide estimates of the current stock size of the oyster resource within each CSA. The information these data provide allow resource managers to implement management changes to both effectively use the current resource and protect its long-term viability.

Oysters also play an important ecological role in the estuarine ecosystem. Oyster reefs provide the majority of hard substrate required by other sessile invertebrate species such as barnacles, bryozoans, tunicates, and anemones. Many species of invertebrates and fish also use oyster reefs as shelter and forage habitat. The oyster's filter-feeding activities enhance estuarine water quality, and oyster reefs can also help stabilize shorelines.

FIGURE 1. Public oyster areas of Louisiana. The Louisiana Wildlife and Fisheries Commission designates public oyster seed grounds. The Louisiana Legislature designates public oyster seed reservations and Calcasieu and Sabine Lakes. Public oyster seed grounds include Lake Borgne, Chandeleur/Breton Sound (primary public oyster seed grounds), Barataria Bay, Little Lake, Deep Lake, Lake Chien, Lake Felicity, Lake Tambour, Lake Mechant, and Vermilion/Cote Blanche/Atchafalaya Bays. Public oyster seed reservations include Bay Gardene, Hackberry Bay, Sister (Caillou) Lake, and Bay Junop. Other public oyster areas include Calcasieu and Sabine Lakes.

Louisiana Oyster Landings

Oysters have been part of Louisiana's economy since the 1800s. Louisiana regularly leads the nation in oyster production, accounting for an average of 34 percent of annual landings of all oysters in the United States from 1997 through 2017 (*Figures 2 and 3*). *Figures 2 and 3* also show that the value of landed oysters differs regionally. Louisiana commercial fishermen have harvested more than 11 million pounds of oysters every year since 2010, including 13.3 million pounds in 2017 (LDWF data). Among the Gulf of Mexico states, Louisiana consistently ranks first in landings, accounting for 75.3 percent of all oysters landed in the region in 2017.

Historically, public oyster areas were considered the backbone of Louisiana's oyster resource. These areas were a valuable contributor to overall Louisiana oyster landings each year, while also supplying seed oysters transplanted to private leases for grow-out purposes. However, the trend from 1970 to 1992 showed the majority of Louisiana oyster landings came from private reefs. From 1992 to 2001, the oyster stock size on public areas generally increased, and landings from the public oyster areas increased as well. In 2009, harvest levels on the public oyster areas significantly decreased from 2008 levels, with the public oyster areas producing only 22 percent of all oyster landings for the calendar year. Production from the public oyster areas did not recover from 2009 to 2017, and data showed only 3.6 percent of all oysters landed in Louisiana came from public oyster areas in 2017 (*Figure 4*).

Stock Assessment Methods

During the summer, LDWF biologists collect field samples from each CSA across Louisiana to perform a quantitative evaluation of the oyster resource on the state's public oyster areas (*Figure 5*). Biologists SCUBA dive on designated sampling stations within each CSA. At each sampling station, they randomly place an aluminum square-meter frame (quadrat) on the oyster reef and collect by hand all live and dead oysters, reef-associated organisms, and exposed reef material from the upper portion of the substrate within the quadrat. They replicate this process five times at each sampling

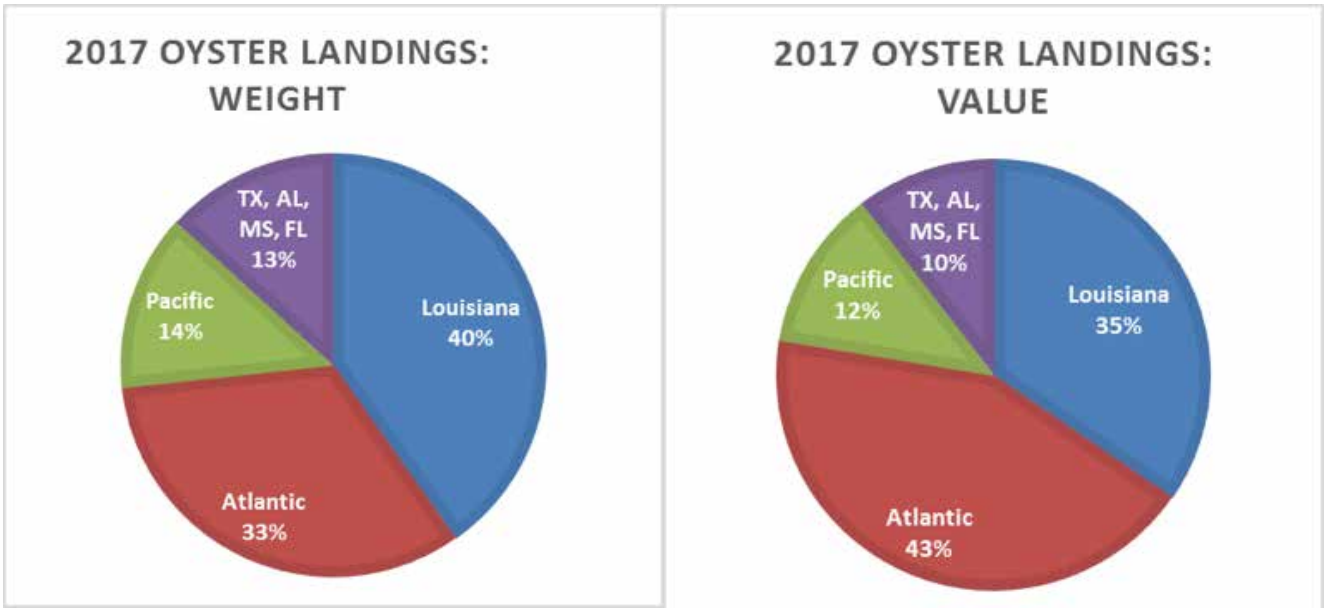

FIGURE 2. Percentage contribution of regions to average annual landings of all oysters in the United States in 2017 (National Oceanic and Atmospheric Administration's National Marine Fisheries Service data).

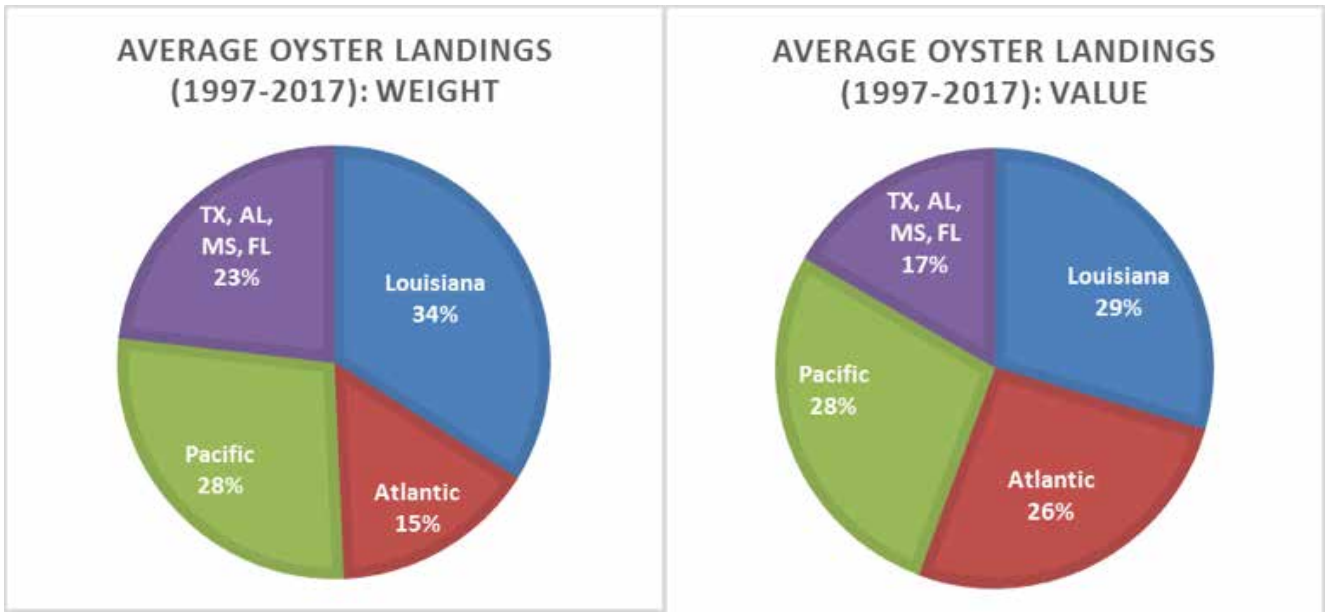

FIGURE 3. Percentage contribution of regions to average annual landings of all oysters in the United States, 1997-2017 (National Oceanic and Atmospheric Administration's National Marine Fisheries Service data).

station. They typically alter this methodology when sampling recent cultch plants and collect five random quarter-square-meter samples in five locations chosen by random grid selection.

Biologists identify, separate, and count live and dead oysters, spat, fouling organisms, oyster predators, and hooked mussels (*Ischadium recurvum*) collected from each station. They measure all oysters, place them into 5-millimeter (mm) size groups and subsequently divide them into three categories: spat (0-24 mm), seed (25-74 mm), and sack (market-size; 75 mm and larger) oysters. They combine all of these data to produce average numbers of spat, seed, and market-size oysters per station. They then multiply the average number of oysters per station by the associated reef acreage to obtain an estimate of the total oysters present on public oyster areas. They convert the resulting numbers from these dive samples into a barrel (bbl) unit of measure where 1 bbl equals 720 seed oysters or 360 market-size oysters. Biologists generate oyster mortality estimates by dividing the total number of recently dead oysters by the total number of oysters (both live and dead) collected.

Biologists collect water temperature, dissolved oxygen, and salinity data in conjunction with the square-meter samples. They also identify and weigh cultch material types. LDWF biologists visited a total of 106 sampling stations during the 2018 oyster stock assessment, gathering 530 individual samples. The annual oyster stock assessment presents sampling data by each CSA. During 2018 assessment sampling, CSA 1 South had the most sampling stations (31) while CSA 5 East held the fewest (3). There is a higher density of sampling in the Black Bay (CSA 1 South) and Sister Lake (CSA 5 West) areas due to their high level of oyster production in past years and historical importance to the oyster

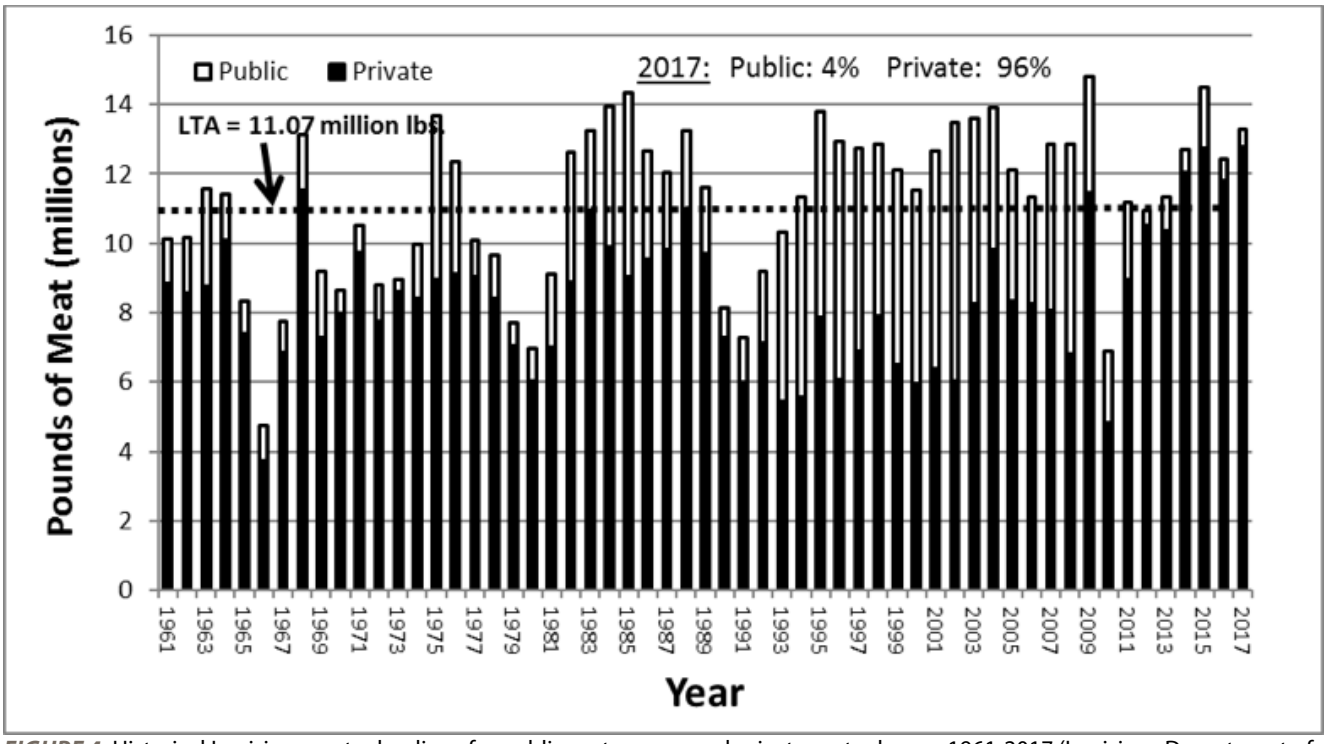

FIGURE 4. Historical Louisiana oyster landings for public oyster areas and private oyster leases, 1961-2017 (Louisiana Department of Wildlife and Fisheries and National Oceanic and Atmospheric Administration's National Marine Fisheries Service data).

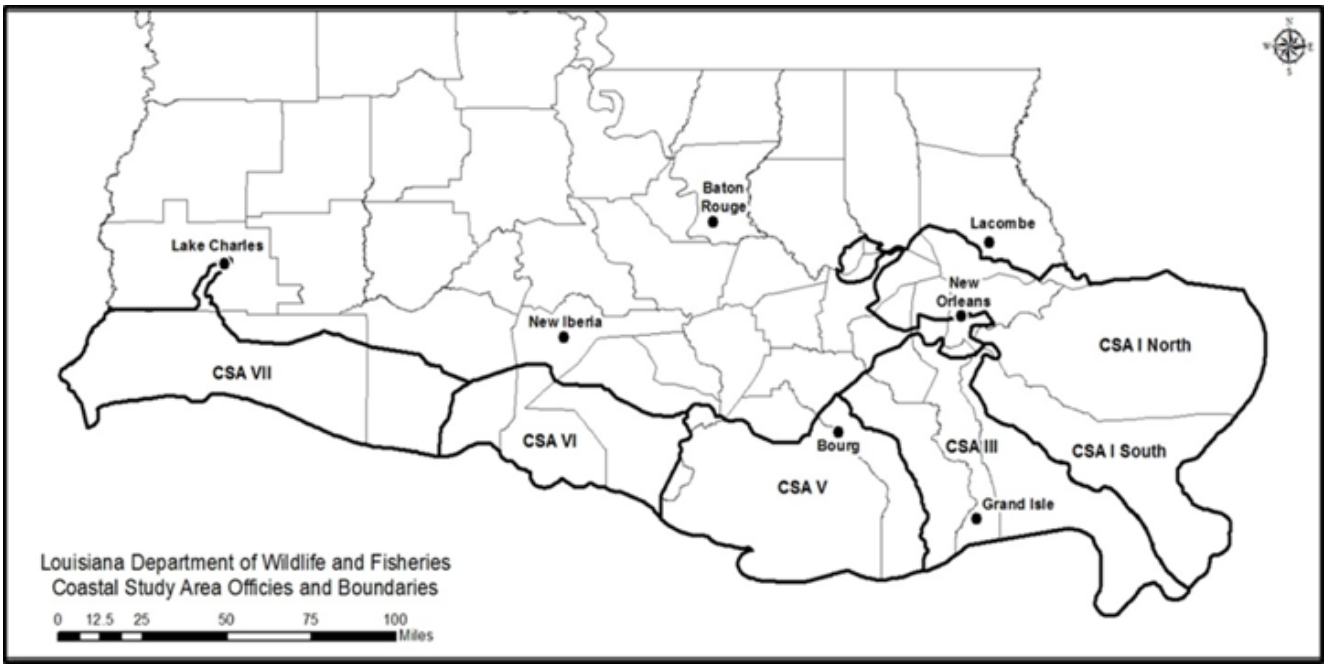

FIGURE 5. Louisiana Department of Wildlife and Fisheries coastal study areas.

industry. Ten of the 106 sampling stations were located on cultch plants constructed since 2011.

Sampling conducted as part of the annual oyster stock assessment plays a valuable role in predicting the success of the upcoming oyster season, which generally opens in early September and runs through April of the following year (although the season may be closed or delayed if biological concerns or enforcement problems are encountered). LDWF uses annual oyster stock assessment information to make recommendations regarding setting the oyster season to the Louisiana Wildlife and Fisheries Commission (Commission).

Annual Stock Size

The 2018 estimated oyster stock on Louisiana's public oyster areas was approximately 266,782 bbls of oysters (*Table 1*), an approximate decrease of 6 percent from the 2017 stock estimate and an 91 percent decrease from the long-term average (1961 through 2017; *Figure 6*). Statewide, the seed oyster stock decreased 25.2 percent while the market-size oyster stock increased 25.7 percent compared to 2017 (*Figures 7 and 8*). The increase in the market-size oyster stock was observed in CSA 1, CSA 5 (Sister Lake), and CSA 7. The seed oyster stock only increased in Calcasieu Lake. Sabine Lake

was not sampled in 2018 nor included in the 2018 CSA 7 stock assessment (see Recent Legislation section: Act 159: permanent moratorium on oyster fishing in Sabine Lake). All statewide comparisons of 2018 to 2017 data were made with assumption of Sabine Lake stocks removed from tallies in 2017 only.

The 2018 estimated oyster stock size in CSA 1 North was 79,954 bbls, an approximate 23.5 percent decrease from 2017, a 79.5 percent decrease from the 10-year average, and an 89.9 percent decrease from the long-term average (1996-2017). The 2018 estimated stock size was largely driven by the oyster densities observed on the Halfmoon Reef Complex in Mississippi Sound. This area accounted for 36.4 percent of total assessed seed oyster stock as well as 62.6 percent of total assessed market-size oyster stock in CSA 1 North.

Oyster production on public oyster areas in CSA 1 South in 2018 continued to be seriously impaired. The 2018 estimated oyster stock size was only 675 bbls of seed oysters. Biologists observed no market-size oysters during sampling. Overall, the 2018 estimated oyster stock size in CSA 1 South decreased 89.8 percent from 2017, 99.5 percent from the 10-year average, and nearly 100.0 percent from the longterm average (1982-2017). The seed oyster stock estimate showed no change when compared to 2017, however it was down 99.2 percent from the 10-year average and 99.9 percent from the long-term average (1982-2017). Aside from occasional extreme events (oil spills, tropical storms), oyster production in CSA 1 South was largely inhibited by extended periods of low spring salinities and possibly periods of hypoxia in the summer and fall that decreased spawning success and increased risk of mortality. Past harvest pressure, combined with poor hydrology for oyster production, has largely degraded reef areas to shell hash and mud that is heavily fouled with mussels and other organisms, resulting in another population stressor through the lack of suitable substrate to enable spat settlement.

The public oyster resource west of the Mississippi River in the Barataria-Terrebonne estuary (CSA 3 and CSA 5) is largely driven by oyster availability in two public oyster seed reservations - Hackberry Bay and Sister Lake. The 2018 estimated oyster stock size in the Hackberry Bay Public Oyster Seed Reservation was 3,538.1 bbls, a 60 percent decrease in total stock size compared to 2017 and 79.7 percent decrease from the 10-year average. Seed oyster availability in 2018 decreased 42.6 percent to 2,033.8 bbls and was 85.1 percent below the long-term average (1982-2017). The market-size oyster stock size decreased 72.8 percent to 1,459.1 bbls and was 80.3 percent below the long-term average. There was an overall reduction in market-size oyster stock at all but one station, Middle Hackberry. The highest availability of market-size oysters was at the 2012 and 2014 Hackberry Bay cultch plants. There were 899.3 bbls of seed oysters available at the 2012 Hackberry Bay Cultch Plant, 809.4 bbls available at the 2014 Hackberry Bay Cultch Plant, and 281 bbls available at the 2008 Hackberry Bay Cultch Plant.

In Sister Lake, the most productive oyster area in the Terrebonne Basin, estimated 2018 seed and market-size oyster availability was 68 percent and 80 percent below long-term averages, respectively. The overall availability also decreased 20 percent compared to 2017 and was estimated at 68,282 bbls, with the Grand Pass Reef Complex containing 93 percent of available market-size oysters.

Due to a lack of side-scan sonar or water bottom assessments in CSA 6, oyster reef acreage in this area is unknown; therefore, it is not possible to calculate density of the reefs in this area.

Public oyster areas in CSA 7 accounted for 41.9 percent of the statewide oyster stock in 2018 (*Table 1, Figure 8*). Compared with 2017, the 2018 overall estimated oyster stock size in Calcasieu Lake increased 49.7 percent, the seed oyster stock (30,458 bbls) increased 35.1 percent, and the market-size oyster stock (81,245 bbls) increased 56.1 percent. However, the overall Calcasieu Lake oyster stock was 67 percent below the long-term average. Sabine Lake is closed indefinitely, no longer factored into annual oyster stock assessments, and only sampled every other year. It was not sampled in 2018.

Harvest Monitoring Methods

LDWF estimates harvest and associated activities by the commercial oyster industry during the oyster season by monitoring users to obtain fishery dependent data. To estimate harvest in a particular reef complex on a weekly basis, biologists conduct boarding surveys on portions of the public oyster seed grounds with an "OPEN" designation under the Louisiana Department of Health (LDH) classification system. They survey the entire area, observing fishermen, recording locations, and making daily harvest estimates for each vessel. When biologists encounter fishermen working the seed grounds, they interview them regarding estimates of past and current catch rates as well as future fishing effort. They summarize the data weekly to maintain a cumulative estimate of harvest for specific reef complexes. They project these harvest estimates over the amount of fishable days (days with winds less than 25 mph) for

TABLE 1. Estimated statewide oyster stock size in barrels (bbls) on Louisiana's public oyster areas by coastal study area. Seed %, Market-Size %, and Total % columns indicate the percent change in that region and size category from the prior assessment. Note that 1 bbl equals two sacks. Green text indicates increases over 2017 levels; red text indicates decreases.

CSA	Seed	Seed %	Market-Size	Market-Size %	Total	Total %
1 North	49,321	-34.4	30,633	-4.7	79,954	-23
1 South	675	0	0	-100	675	-90
3	2,079	-41	1,459	-73	3,538	-60
5 East	452	-35	0	n/a	452	-35
5 West	48,358	-34	22,146	+46	70,504	-20
7	30,458	+35	81,246	+56	111,704	+50
Total	*131,298*	*-34*	*135,484*	*+20*	*266,782*	*-6*

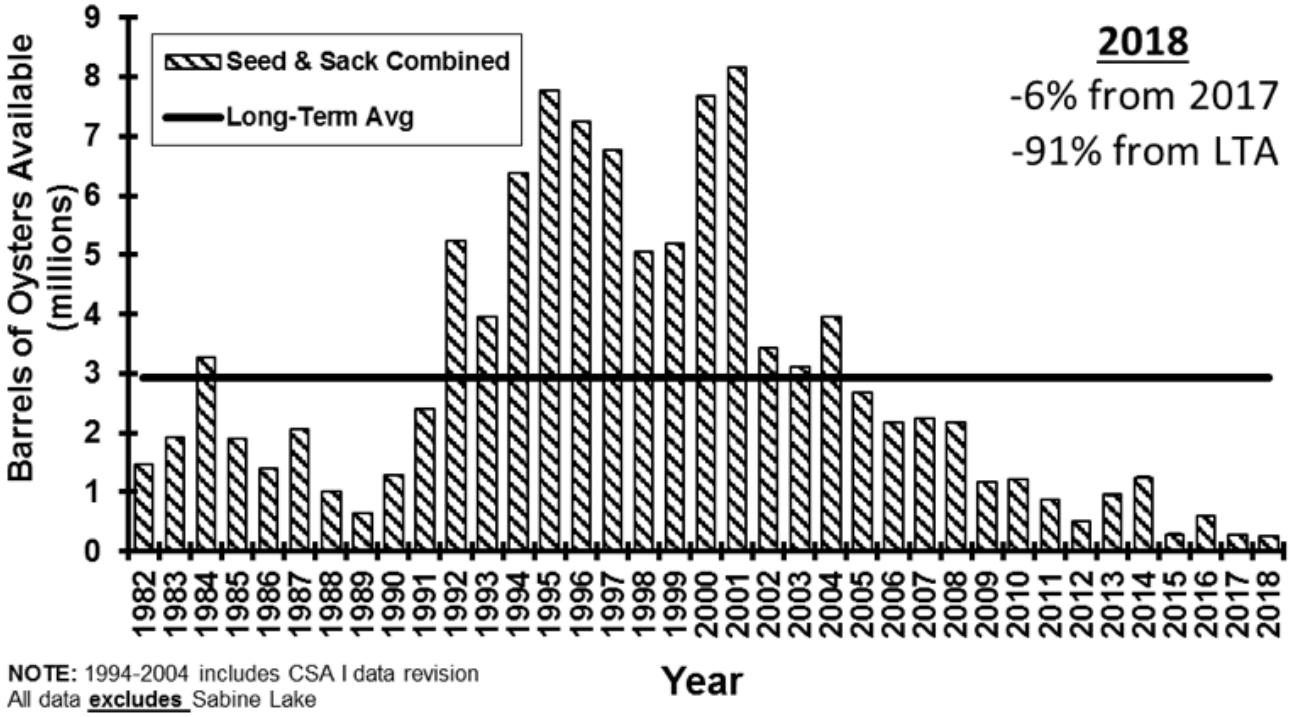

FIGURE 6. Historical oyster stock availability on Louisiana's public oyster areas. LTA denotes the long-term average from 1982 through 2018.

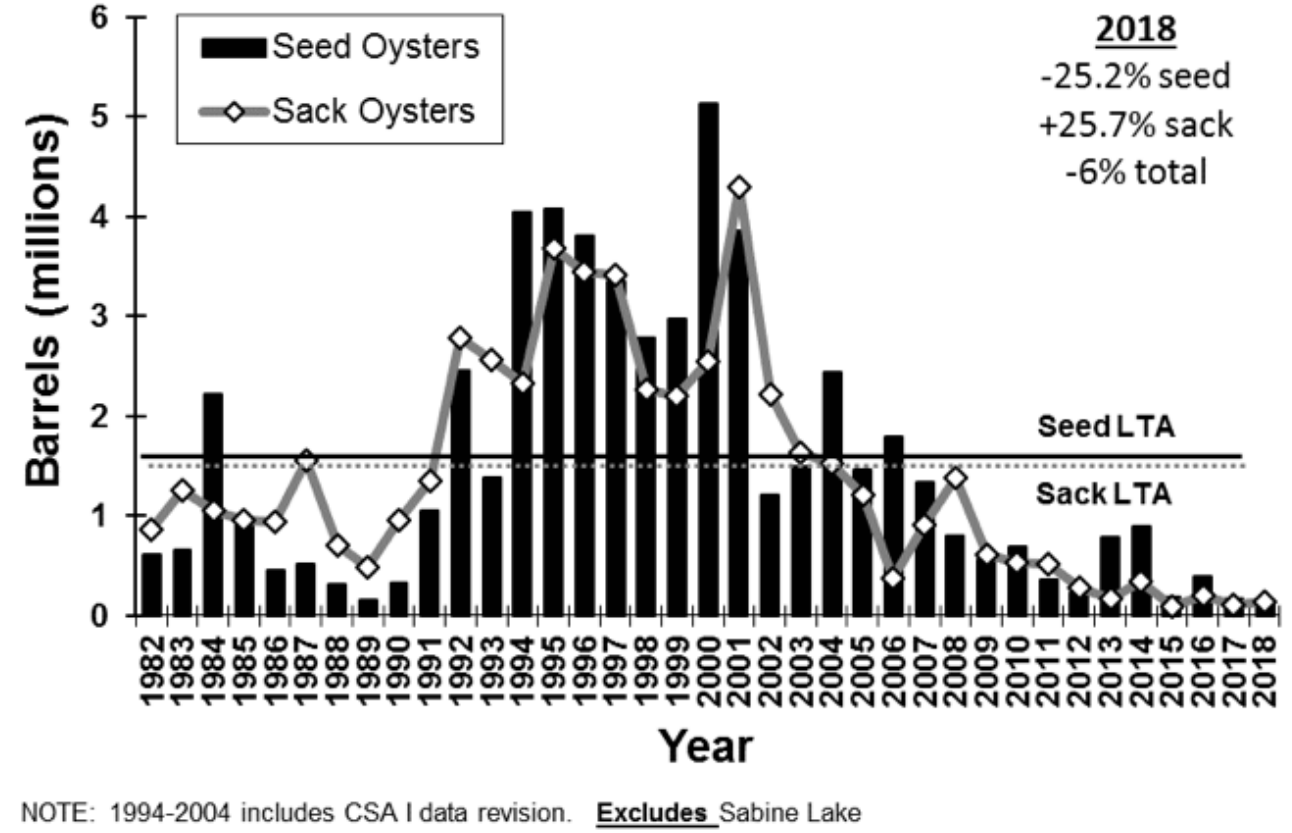

FIGURE 7. Historical seed and market-size oyster stock availability on Louisiana's public oyster areas. LTA denotes the long-term average from 1982 through 2018. Percentages indicate change from 2017.

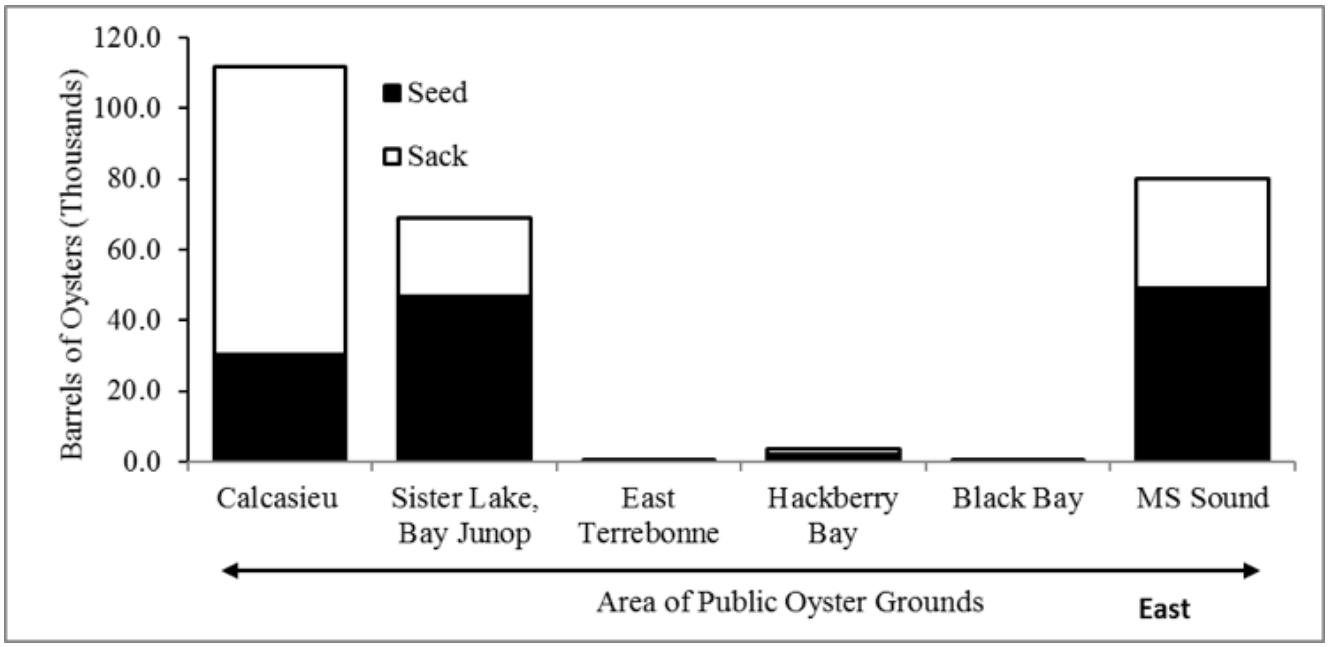

FIGURE 8. Statewide distribution of oyster stocks on Louisiana's public oyster areas in 2018.

the week to determine a total harvest estimate of seed and market-size oysters for the week. Biologists often board vessels to collect seed oysters to determine if fishermen are removing excessive amounts of cultch (nonliving reef material) from area reefs.

LDWF also obtains harvest data via its trip ticket system. However, trip ticket data provide limited resolution as they are consolidated by geographic region and are considered preliminary until well after the season concludes.

2017/2018 Oyster Season

Total estimated commercial harvest slightly increased (+0.7 percent) during the 2017/2018 oyster season compared to the previous season (*Table 2*). Oyster availability has been declining over the past 10 years. Heavy localized harvest, high mortality, strong tropical events, environmental changes, and lack of recruitment have contributed to an ongoing downturn in oyster production. The slight increase in harvest in 2017/2018 was mostly due to an emergency opening for bedding in response to Bonnet Carré Spillway opening and an additional special relay opening in Lake Borgne in LDH Harvest Areas 1 and 2. Without these emergency and special openings, commercial harvest from the 2017-2018 oyster season would have reached a new record low. Market-size oyster harvest decreased statewide partly due to season closures in Hackberry Bay and the Eastside of Lake Calcasieu.

Special Oyster Management Projects

LDWF biologists continue to participate in several important projects to increase oyster production on Louisiana's public oyster seed grounds and reservations. LDWF has used cultch planting to rehabilitate reefs since 1917. Two cultch plant projects have been completed since the 2017 oyster stock assessment: a new 100-acre cultch plant (limestone) in Lake Calcasieu completed in the fall of 2017 and a replenishing of cultch and deposit of spat-on-shell in Lake Fortuna in 2018. (Spat-on-shell is remote setting where oyster larvae is produced in a hatchery setting and set on oyster shells.) In Lake Fortuna, 16,000 cubic yards of dry shell were deposited in April 2018, followed by spat-on-shell deposited in August 2018.

The Michael C. Voisin Oyster Hatchery located on Grand Isle, Louisiana, is operated through a collaborative effort between LDWF and Louisiana Sea Grant. Louisiana Sea Grant assists with facility operations and provides recommendations to LDWF for hatchery operations. The hatchery produces diploid, triploid, and tetraploid oyster larvae and seed and algae feed for industry orders, restoration projects, breeding programs, and research projects. The hatchery produced approximately 229 million oysters in 2018, and LDWF began managing larval and seed sales in January 2018 with the majority of orders received being for triploid larvae. For the periods during the spring 2018 season when there was a surplus of diploid or triploid pediveliger larvae and/or seed, LDWF set the extra pediveligers onto macro-cultch (ground up pieces of oyster shell) to produce spat-on-macro-cultch for restoration purposes. Biologists deployed the spring spat-on-macro-cultch, as well as surplus seed, along The Nature Conservancy's living shoreline site near Lake Fortuna (650 meters of shoreline stabilization structure). Approximate numbers of diploid and triploid products deployed were 56,775 diploid spat-on-macrocultch, 128,059 triploid spat-on-macro-cultch, and 527,351 triploid seed. Additional hatchery focuses included refining techniques to improve the management of water quality, improve algal production, and improve other systems of the hatchery.

Additional projects include continued evaluation of shell-budget modeling efforts.

Recent Legislation

During the 2018 regular legislative session, the Louisiana Legislature (Legislature) passed Act 159, placing a permanent moratorium on the harvest of oysters in Sabine Lake. Due to this legislation, LDWF has decided to conduct oyster stock assessments in Sabine Lake every other year. The last assessment was completed in 2017; no Sabine stock assessment was conducted this year.

TABLE 2. Harvest estimates for the 2017/2018 oyster season on Louisiana's public oyster areas. Data derived from fishery dependent surveys of harvesting vessels rather than LDWF trip ticket data. Note that there is no oyster season in Sabine Lake and that 1 barrel (bbl) equals 2 sacks.

CSA	Seed Oysters (bbls)	Market-Size Oysters (sacks)	Total (bbls)
1 North	25,260	17,872	34,196
1 South	0	0	0
3	0	0	0
5 East	0	0	0
5 West	6,410	25,290	19,055
6	8,450	830	8,865
7 West Cove Calcasieu	0	8,526	4,263
7 Eastside Calcasieu	0	0	0
Total	***40,120 (+12.0%)***	***52,518 (-12.7%)***	***66,379 (+0.7%)***

Conclusion and Acknowledgments

The following report includes both biological stock assessments and historical oyster landings data from each CSA in Louisiana, as well as a brief summary of the most recent oyster season in each area. Biological data were generated from quantitative square-meter sampling (see above); landings data were generated from boarding surveys and trip ticket information.

This report was prepared by Carolina Bourque, Carl Britt, Willie Cheramie, Jeff Marx, George Melancon, and Chris Schieble. Biologists from each CSA spent extensive time gathering samples and producing the report. Additionally, Bryan Alleman, Harry Blanchet, Katie Chapiesky, Denise Kinsey, Ty Lindsey, and Christian Winslow assisted with editorial review and preparation of this document. Efforts of both the field and office staff are greatly appreciated, as this report could not be produced without their hard work and dedication. Please direct questions and/ or comments to Carolina Bourque, Oyster Program Manager, at 337-735-8726 or cbourque@wlf.la.gov.

CSA 1 NORTH

Introduction

The public oyster seed grounds in CSA 1 North (North Pontchartrain Basin) consist of approximately 690,000 acres of water bottom located within Lake Borgne, the Louisiana portion of Mississippi Sound, Chandeleur Sound, the Biloxi Marsh, and adjacent waters. Louisiana, Mississippi, and Texas fishermen harvest oysters from this area, which has historically been an area of high oyster production within the state of Louisiana. Although the State of Louisiana has managed this area as public oyster seed grounds for many decades, the Commission did not designate the majority of this area by rule until 1988. The Commission designated much of Lake Borgne as a public oyster seed ground in 1995 and expanded the grounds in 2004. LDWF continually expands and enhances public oyster reefs through the placement of cultch material (i.e. shell, limestone, crushed concrete) on suitable water bottoms. Most recently, LDWF completed cultch plants in Mississippi Sound (Round Island) in 2011 and Three Mile Pass and Drum Bay in 2013 as part of the *Deepwater Horizon* oil spill Natural Resource Damage Assessment (NRDA) Early Restoration Program.

Methods

LDWF biologists collected field samples for this oyster stock assessment between June 27 and July 09, 2018, from a total of 20 sampling stations within CSA 1 North according to the methodology described in the Statewide Overview of this report. Sampling stations included 17 historical stations as well as the 2011 cultch plant in Mississippi Sound (Round Island) and the two 2013 NRDA Early Restoration cultch plants in Three Mile Pass and Drum Bay (*Figure 1.1*).

Before the 2013 CSA 1 North oyster stock assessment, LDWF assessed an estimated 20,442.5 acres of reef based upon water bottom surveys completed in the mid-1970s. To better locate and assess the oyster stock on the public oyster seed grounds, LDWF has conducted a number of side-scan sonar studies of water bottoms in these areas in recent years. These studies coupled with historical reef and cultch plant information resulted in a more up-to-date and realistic designation of productive water bottoms for use in the annual oyster stock assessment (*Table 1.1*). The 2018 CSA 1 North oyster stock assessment is based on the updated reef assessment of 22,427.1 acres of water bottom, which includes 649 acres of recent cultch plants. As those cultch plants are distinctly different from surrounding existing reef in terms of oyster productivity, LDWF assesses cultch plant acreages separately from the surrounding reef complex.

Beginning with the 2013 CSA 1 North oyster stock assessment, the reef acreage for the Millennium Reef Cultch Plant in western Mississippi Sound was added to a reef complex that includes Grassy Island, Halfmoon Island, Petit Island, and Grand Banks. LDWF had previously assessed Millennium Reef's 70 acres as a separate reef since its construction in 2000. Side-scan sonar studies revealed that the majority of this reef fell within the Halfmoon Island Reef Complex, and biological sampling indicated that it was no longer distinctively different from surrounding reef acreage. Conversely, LDWF assesses the 2011 Mississippi Sound Cultch Plant (Round Island) and the two 2013 NRDA Early Restoration cultch plants (Three Mile Pass and Drum Bay) separately from surrounding reef systems. Although these cultch plants were opened to harvest since the 2015/2016 oyster season, they are still significantly different in productivity from nearby reef systems.

Only productive public oyster seed grounds for which an accurate acreage can be determined are included in the oyster stock assessment. For this reason, some areas, such as public oyster seed grounds located within Lake Borgne, are not included in this oyster stock assessment due to a lack of reef acreage information.

Results and Discussion

Seed and Market-Size Stock

The 2018 estimated oyster stock size for CSA 1 North is 49,321 bbls of seed oysters and 30,633 bbls of market-size oysters, for a total of 79,954 bbls of overall stock (*Table 1.2*). Compared to 2017, there was a 34.4 percent decrease in the seed estimate and a 4.5 percent increase in the market-size estimate. This year's estimated seed stock is down 78.0 percent from the 10-year average, while the estimated market-size stock is down 81.5 percent from the 10-year average (*Figure 1.2*). The total estimated oyster stock for 2018 is down 23.5 percent from 2017 and is 79.5 percent below the 10-year average. When compared to the long-term average (1996-2017), the total estimated oyster stock is down 89.9 percent.

Oyster density and abundance were not evenly distributed among areas. This year's stock estimate is largely driven by the oyster densities observed on the Halfmoon Island Reef Complex in Mississippi Sound. The Halfmoon Island Reef Complex, which includes Grassy Island, Halfmoon Island, Petit Island, Grand Banks, and Millennium Reef, is estimated to hold 37,134 bbls of total oyster stock. This area accounted for 36.4 percent of total assessed seed oyster stock, as well as 62.6 percent of total assessed market-size oyster stock in CSA 1 North. The 2018 estimated seed stock was further bolstered by oyster resource on Round Island and the Three Mile Pass Cultch Plant, where the highest density estimates of seed oysters were observed. The highest density estimates of market-size oysters were found at the Grassy Island and Round Island sampling stations. It is important to note variability both within and among sampling stations when comparing estimates. This variability is magnified when extrapolating small sample sizes

TABLE 1.1. Comparison of historical and current reef complex acreages in Coastal Study Area 1 North.

Station Name	Station Number	Historical Reef Acreage	Current Reef Acreage
Grassy Island	3005	6,559.2	5,328.0
Halfmoon Island	3010		
Petit Island	3009		
Grand Banks	3044		
Millenium Reef	3011	70.0	
Three Mile Bay	3008	3,058.7	3,058.7
East Karako Bay	3040		
West Karako Bay	3041		
Grand Pass	3007	1,801.8	5,411.0
Cabbage	3006		
Turkey Bayou	3004		
Martin Island	3046	4,155.7	3,183.3
Holmes Island	3045		
Johnson Bayou	3051	200.0	200.0
Drum Bay	3049	1,596.0	1,596.0
Morgan Harbor	3050	2,954.0	2,954.0
Shell Point	3052	47.2	47.2
Round Island	3056	Not assessed	291.0
Drum Bay Cultch Plant		Not assessed	200.0
Three Mile Pass Cultch Plant		Not assessed	158.0
Total		***20,442.5***	***22,427.1***

to large areas. In short, changes between annual assessments can be dramatic on an individual reef basis, and only limited areas of significant resource availability are often identified.

Over the past 10 years, CSA 1 North has experienced heavy localized harvest, high mortality events, strong tropical events such as Hurricane Isaac in 2012 and Hurricane Nate in 2017, the *Deepwater Horizon* oil spill and related spill response activities, multiple Bonnet Carré Spillway openings, and continual limits to recruitment that appear to have severely reduced oyster resources. As a result, both the estimated seed and market-size oyster stocks are again below the 10-year average and continue to fall well below the long-term averages (*Figure 1.2*).

Spat Production

Live spat were observed at 8 of the 20 stations sampled during this assessment. At these stations, mean densities ranged from 0.4 to 10.6 individuals per square meter (m^2) with the maximum value occurring at Grand Banks. Occurrence of spat oysters decreased from the previous year's assessment, which continues an observed lack of spat set over several of the reef areas during the spring spawning events. This could be attributed to several factors such as freshets, hypoxia, overburden or dissolution of cultch, or a combination of these stressors. It is noted that annual square-meter samples may occur between seasonal spawning events in some areas, and that spat numbers are somewhat biased by the amount of substrate collected in a given sample.

Fouling Organisms

The hooked mussel, a sessile bivalve often associated with oyster reefs that likely competes with oysters for food and settlement surfaces, was observed at 8 of the 20 stations during this sampling event (*Table 1.3*). The highest density of mussels was 161.2 per m^2 at Grassy Island. There was a marked increase in hooked mussel densities across most of CSA 1 North when compared to the previous year's observations, likely because of freshwater influences from high Pearl River discharge and the opening of the Bonnet Carré Spillway. High river discharge causes lower salinities in this area, which improves conditions for hooked mussel growth.

Oyster Predators and Disease

The southern oyster drill (*Stramonita haemastoma*) is a marine gastropod known to prey on oysters using a small toothlike scraping organ called a radula to bore a hole through the oyster shell. During this year's sampling event, oyster drills were observed at five sampling stations. Cabbage Reef and Grand Banks had the highest densities of oyster drills present, with 0.8 per m^2 and 0.6 per m^2 respectively. No stone crabs (*Menippe adinia*) or blue crabs (*Callinectes spp.*) were collected in the square-meter samples. Other Xanthid crabs were noted in the samples that contained shell for substrate.

Dermo (*Perkinsus marinus*), a protozoan parasite that infects live oyster tissue, is known to cause extensive oyster mortalities especially in high salinities and water temperatures. Oyster tissue

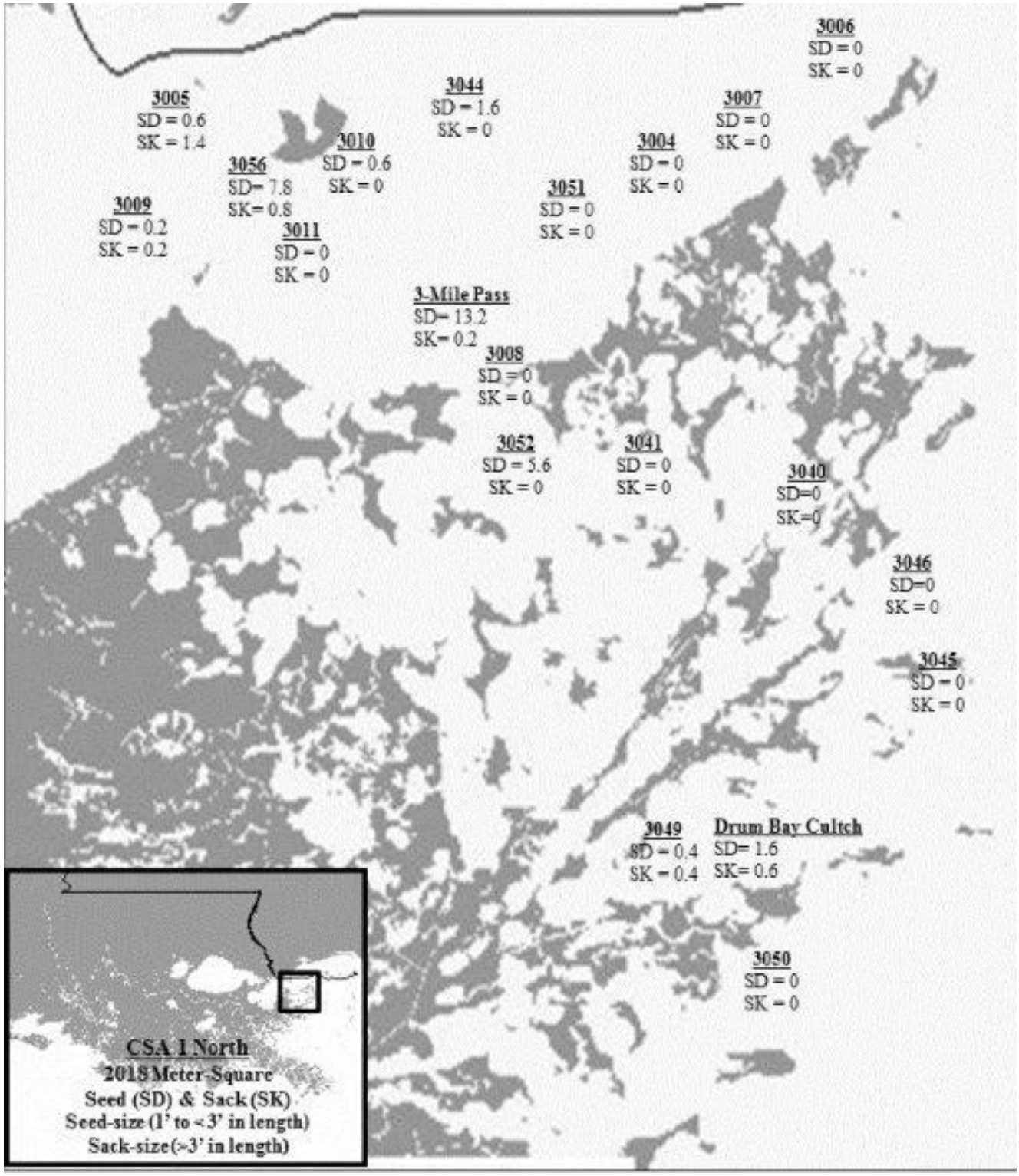

FIGURE 1.1. 2018 Coastal Study Area 1 North oyster stock assessment sampling stations. Numbers below stations are average numbers of seed (SD) and market-size (SK) oysters per square meter.

samples to be tested for presence of this parasite were collected from the Cabbage Reef and Three Mile Bay reef complexes in CSA 1 North. Results of the Dermo tests are presented in Appendix I.

Mortality

Overall, mortality estimates slightly increased from the previous year's stock assessment, with observations at three sampling stations (*Table 1.4*). Spat oyster mortalities were recorded at Grand Banks and Cabbage Reef during this sampling event. Round Island had the only seed mortality at just 2.5 percent. Grand Banks also accounted for the only observed market-size oyster mortality during this assessment, where only recently deceased market-size oysters were present in samples. It is important to consider that mortality estimates are often based on an extremely small number of animals. Further, for some annual stock assessments, samples may be taken shortly after large mortality events that

have either diminished or severely depleted abundances, so that neither the mortality nor the prior abundance is fully captured in the assessment sampling.

Tropical and Climatic Events

While freshets often benefit the reef system, either by reducing disease or predation or by enhancing cultch opportunities via the shells of recently dead oysters, there are often other cumulative impacts that may affect recovery from any one event. The impacts and subsequent recovery are also modified by not only the magnitude of a freshet, but perhaps also by the duration and timing.

During the 2018 oyster stock assessment, the Pearl River system discharged a large volume of fresh water into the western Mississippi Sound from February through April 2018, as it stayed at or just below flood stage for an extended period of time. In addition, the Bonnet Carré Spillway was open from March 8, 2018, through March 30, 2018, routing a massive volume of Mississippi River water into CSA 1 North.

During periods of high Pearl River discharge, salinities on the reef systems in Mississippi Sound tend to decrease, stressing oysters in that portion of the basin. These decreases in salinity are further exacerbated by the introduction of Mississippi River water through the Bonnet Carré Spillway. There were notable decreases in salinities across CSA 1 North between the months of February and May 2018. This is evidenced by salinities being recorded as low as 1.5 parts per thousand (ppt) at Grassy Island in March and 1.3 ppt at Petit Island during the month of April. Although these values are discreet measurements, similar low salinity values were also collected by non-related observations, as well as data derived from continuous salinity recorders within the area.

At the time of the 2018 oyster stock assessment, the potential for hypoxic conditions was detected throughout CSA 1 North with most sampling stations having dissolved oxygen levels less than 6.0 milligrams per liter (mg/L). Morgan Harbor had the lowest bottom dissolved oxygen reading of 2.0 mg/L. Bottom dissolved oxygen measurements at remaining sampling stations ranged from 3.3 to 5.8 mg/L.

2017/2018 Oyster Season

The 2017/2018 oyster season in CSA 1 North opened on Nov. 13, 2017, for both seed and market-size oyster harvest, with a 50-sack per day limit (*Figure 1.3*). Due to an abundance of spat observed in regular monthly dredge samples in the area, this opening was delayed to increase the likelihood of survival of the spat resource. All seed oyster harvest in CSA 1 North was suspended on Nov. 14, 2017, amounting to a one-day bedding season. During previous

TABLE 1.2. Mean density of oysters collected at each sampling station in Coastal Study Area 1 North.

Station Name	Station Number	Reef Group Acreage	Seed Oysters/m²	Market-Size Oysters/m²	Number of Seed Oysters (bbls)	Number of Market-Size Oysters (bbls)
Grassy Island	3005	5,328.0	0.6	1.4	17,968	19,166
Halfmoon Island	3010		0.6	0.0		
Petit Island	3009		0.2	0.2		
Grand Banks	3044		1.6	0.0		
Millenium Reef	3011		0.0	0.0		
Three Mile Bay	3008	3,058.7	0.0	0.0	0	0
East Karako Bay	3041		0.0	0.0		
West Karako Bay	3040		0.0	0.0		
Grand Pass	3007	5,411.0	0.0	0.0	0	0
Cabbage Reef	3006		0.0	0.0		
Turkey Bayou	3004		0.0	0.0		
Martin Island	3046	3,183.3	0.0	0.0	0	0
Holmes Island	3045		0.0	0.0		
Shell Point	3052	47.2	5.6	0.0	1,486	0
Johnson Bayou	3051	200.0	0.0	0.0	0	0
Drum Bay	3049	1,596.0	0.4	0.4	3,588	7,176
Morgan Harbor	3050	2,594.0	0.0	0.0	0	0
Round Island	3056	291.0	7.8	0.8	12,758	2,617
Drum Bay Cultch Plant		200.0	1.6	0.6	1,799	1,349
Three Mile Pass Cultch Plant		158.0	13.2	0.2	11,722	355
2018 Total					***49,321***	***30,633***

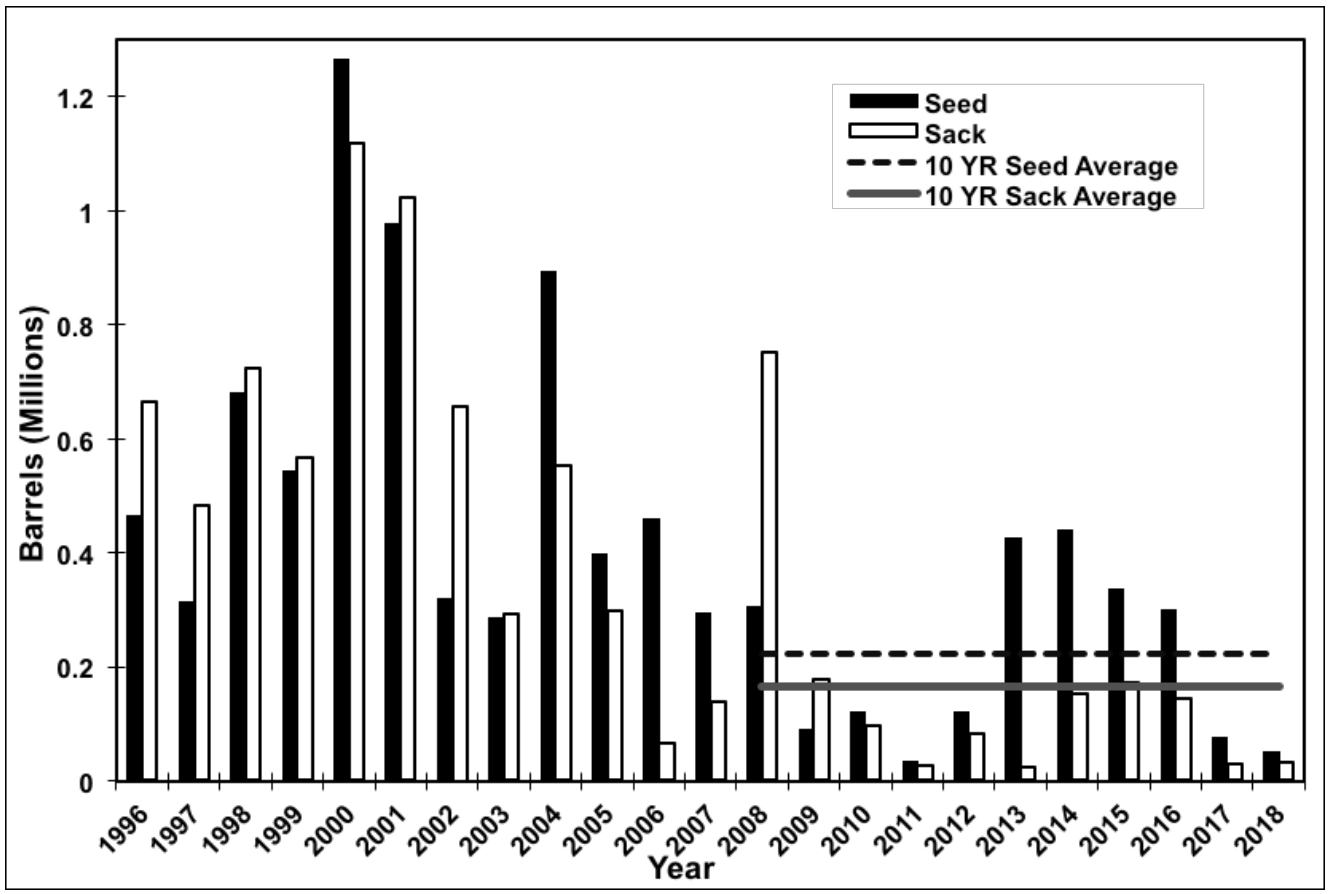

FIGURE 1.2. Current and historical seed and market-size stock size estimates in Coastal Study Area 1 North. Horizontal lines represent the 10-year average seed and market-size stock size estimates.

seasons, surveyed bedding loads contained large percentages of nonliving reef material, prompting LDWF to recommend limiting the amount of seed oyster harvest to maintain healthy levels of substrate on public oyster seed grounds.

The daily sack limit for market-size oysters was reduced from 50 to 25 sacks on Nov. 28, 2017, to ensure these areas could withstand continued but limited harvest to maintain a sustainable harvest of the oyster resource. Two additional opportunities for seed oyster harvest were provided during March and April 2018 due to the opening of the Bonnet Carré Spillway. From March 12 to March 17, 2018, LDH Harvest Area 1 in Lake Borgne was opened to allow the transplant of oysters that might be negatively impacted by Mississippi River water passing through the spillway. From March 24 to April 7, 2018, transplant of oyster resource was allowed from the portion of LDH Harvest Area 2 in Mississippi Sound located within sanitation closures. The 2017/2018 oyster season in CSA 1 North closed on April 30, 2018.

Harvest Results and Discussion

Harvest for CSA 1 North during the 2017/2018 oyster season was estimated at about 35,744 sacks of market-size oysters and 25,630 bbls of seed oysters. Compared with the 2017 stock assessment, there was an estimated use of 59.7 percent of the market-size stock and 34.1 percent of the seed stock. In a general spatial context, this harvest was variable throughout the area (*Table 1.5*). The majority of the market-size oyster stock was harvested from the Three Mile Bay Reef Complex, which includes the Three Mile Pass Cultch Plant. This reef complex accounted for 41.4 percent of the combined market-size oyster harvest. The majority (75.5 percent) of the seed harvest came from the Halfmoon Island Reef Complex in Mississippi Sound, which is directly related to the two bedding relays that took place in this area. In all, the Halfmoon Island Reef Complex produced a combined harvest of 24,387 bbls of oysters. The Drum Bay Reef Complex, including the Drum Bay Cultch Plant, also yielded notable harvest with 21.3 percent of total combined seed and market-size oyster harvest.

While obtaining fishery dependent data, LDWF biologists routinely collect random samples of oyster seed loads from vessels working on the public grounds to determine the percent of cultch (nonliving reef material) being harvested. During the 2017/2018 oyster season, biologists collected 14 such samples from 11 different vessels observed collecting seed oysters from Halfmoon Island, Drum Bay Cultch Plant, Three Mile Pass Cultch Plant, Petit Island, and Grassy Island. Nine samples from Grassy Island yielded cultch percentages ranging from 6.5 to 60.2 percent. The percentage of cultch in one sample from the Three Mile Pass Cultch Plant was calculated to be 28.3 percent, while a single sample from Petit Island was 62.4 percent cultch. Two samples from the Drum Bay Cultch Plant were 56.8 and 71.3 percent cultch. The one sample collected from Halfmoon Island was found to hold 6.7 percent cultch. These observations show a continuing trend of excessive cultch removal from public oyster areas by bedding vessels. Loss of adequate cultch material continues to be a major concern for public oyster seed grounds within CSA 1 North.

TABLE 1.3. Mean density of hooked mussels and southern oyster drills at each sampling station in Coastal Study Area 1 North.

Station Name	Hooked Mussel Density/m²	Southern Oyster Drill Density/m²
Grassy Island	161.2	0.0
Petit Island	5.2	0.0
Halfmoon Island	0.0	0.0
Grand Banks	0.4	0.6
Millennium Reef	0.0	0.0
Three Mile Bay	25.0	0.0
East Karako Bay	0.0	0.0
West Karako Bay	0.0	0.2
Grand Pass	0.0	0.2
Turkey Bayou	0.0	0.0
Cabbage Reef	0.0	0.8
Johnson Bayou	0.0	0.0
Shell Point	10.0	0.0
Drum Bay	0.6	0.2
Morgan Harbor	0.0	0.0
Martin Island	0.0	0.0
Holmes Island	0.0	0.0
Round Island	5.4	0.0
Drum Bay Cultch Plant	3.4	0.0
Three Mile Pass Cultch Plant	0.0	0.0

FIGURE 1.3. Map showing areas that were open/closed for oyster harvest during the 2017/2018 season.

TABLE 1.4. Recent mean oyster mortality estimates from Coastal Study Area 1 North sampling stations (N/A = no live or dead oysters were collected for mortality estimates).

Station Name	Spat Mortality (%)	Seed Mortality (%)	Market-Size Mortality (%)
Grassy Island	N/A	0.0	0.0
Petit Island	N/A	0.0	0.0
Halfmoon Island	N/A	0.0	N/A
Grand Banks	35.4	0.0	100.0
Millennium Reef	N/A	N/A	N/A
Three Mile Bay	0.0	N/A	N/A
West Karako Bay	N/A	N/A	N/A
East Karako Bay	N/A	N/A	N/A
Shell Point	0.0	0.0	N/A
Johnson Bayou	N/A	N/A	N/A
Turkey Bayou	N/A	N/A	N/A
Cabbage Reef	70.0	N/A	N/A
Grand Pass	N/A	N/A	N/A
Drum Bay	0.0	0.0	0.0
Morgan Harbor	N/A	N/A	N/A
Martin Island	N/A	N/A	N/A
Holmes Island	N/A	N/A	N/A
Round Island	0.0	2.5	0.0
Drum Bay Cultch Plant	0.0	0.0	0.0
Three Mile Pass Cultch Plant	0.0	0.0	0.0

TABLE 1.5. Harvest estimates from the 2017/2018 public oyster season in Coastal Study Area 1 North.

Station Name	Seed (bbls)	Market-Size (sacks)
Grassy Island	18,225	380
Halfmoon Island	350	3,263
Petit Island	210	7,286
Lake Borgne	600	755
Millennium Reef	0	0
Grand Banks	0	275
Three Mile Bay	0	6,631
Turkey Bayou	0	0
Johnson Bayou	0	0
Grand Pass	0	15
Cabbage Reef	0	0
West Karako Bay	70	5,136
East Karako Bay	0	215
Drum Bay	0	3,256
Morgan Harbor	0	396
Bay Eloi	0	0
Shell Point	0	681
Round Island	0	0
Three Mile Pass Cultch Plant	250	2,808
Drum Bay Cultch Plant	5,165	4,647
Total	***24,870***	***35,744***

CSA 1 SOUTH

Introduction

The public oyster seed grounds in CSA 1 South (South Pontchartrain Basin), formerly CSA 2, consist of approximately 300,000 acres of water bottom located from the Mississippi River Gulf Outlet (MRGO) southward to South Pass in the Mississippi River delta and eastward from the eastern extent of private leases east of the Mississippi River to the Breton National Wildlife Refuge. These public oyster seed grounds include Bay Gardene Public Oyster Seed Reservation, as well as areas designated as sacking only in Bay Long. Historically, this area has provided seed and market-size oysters for oyster fishermen from Louisiana, Mississippi, and Texas. Hydrology in the area is influenced at high Mississippi River stages by discharge through gaps in the Mississippi River levee south of Pointe a la Hache including the Bohemia Spillway and Bohemia Spillway, discharge from the Caernarvon and Bayou Lamoque freshwater diversion structures, and main-stem river distributaries in the southern portion of the basin. LDWF continually expands and enhances public oyster reefs through the placement of cultch material (e.g. shell, limestone, crushed concrete) on suitable water bottoms. Numerous cultch plants have been constructed throughout CSA 1 South since 1917, including sites in Bay Gardene and Black Bay. Most recently, cultch plants were completed in California Bay in 2011 as well as in Bay Crabe and Lake Fortuna in 2012 as part of the *Deepwater Horizon* oil spill NRDA Early Restoration Program. Currently, LDWF, NOAA, and the St. Bernard Parish Government are working together to enhance a 100-acre portion of the 2012 Lake Fortuna Cultch Plant. To date, 16,154 cubic yards of oyster shell have been deployed on the site.

Methods

LDWF biologists collected field samples for the 2018 oyster stock assessment between June 27 and July 10, 2018, from a total of 31 stations within CSA 1 South according to the methodology described in the Statewide Overview of this report. Sampling stations included 30 historical stations and the 2012 Lake Fortuna Cultch Plant (*Figure 2.1*). Biologists consider the 2012 Lake Fortuna Cultch Plant to be significantly different from surrounding water bottoms and assess this area separately as a result (*Table 2.1*).

To better locate and assess the oyster stock on the public oyster seed grounds, LDWF has conducted a number of side-scan sonar studies of water bottoms in CSA 1 South in recent years. These studies, coupled with historical reef and cultch plant information, have resulted in a more up-to-date and realistic designation of productive water bottoms for use in the annual oyster stock assessment. The 2018 oyster stock assessment is based on the updated reef acreage of 27,662.3 acres of water bottom.

Beginning with the 2013 oyster stock assessment, oyster reefs within CSA 1 South were grouped into reef complexes based on location, hydrology, oyster productivity, and response to environmental stressors. There were a total of 12 reef complexes, each with one to five representative square-meter sampling stations (*Figure 2.2*). Recent water bottom assessments identified an additional 1,524 acres of oyster habitat (reef and scattered shell), but this acreage is not included in the annual oyster stock assessment acreage, as no current oyster sampling station adequately describes this acreage.

Results and Discussion

Seed and Market-Size Stock

The 2018 estimated oyster stock size for CSA 1 South was 674.5 bbls of seed oysters. Biologists observed no market-size oysters during the 2018 oyster stock assessment (*Table 2.2*). However, this does not mean there was a complete absence of market-size oysters. As actual sampling stations are random and include only a small percentage of the total public oyster seed grounds, scattered oyster resource may be present in portions of the area that were not evaluated during this assessment. The results of this stock assessment point to an extremely low abundance of oyster stock across CSA 1 South, a trend that has persisted for a number of years. The 2018 estimate of available seed oyster stock was consistent with the 2017 assessment - abundance and the location of all observed seed oyster stock were unchanged. 2018 sampling results indicated a 100 percent decrease in the amount of available market-size oyster stock from 2017. Overall, oyster stock abundance in CSA 1 South, including both seed and market-size oysters, decreased 89.8 percent from 2017, 99.5 percent from the 10-year average, and 100.0 percent from the long-term average (1982-2017; *Figure 2.3*). The seed oyster stock estimate was down 99.2 percent from the 10-year average and 99.9 percent from the long-term average.

Across the CSA 1 South study area, there were no oysters found of any size category at nearly all of the sampling stations (*Figure 2.1, Table 2.2*). Only the Lake Fortuna Reef Complex, specifically the Lake Fortuna Cultch Plant, was estimated to have any oyster resource. The Lake Fortuna Cultch Plant had seed oysters present, with a density of 0.6 seed oysters per m^2. Over the past 10 years, CSA 1 South has experienced periods of heavy localized harvest, high mortality events, strong tropical events such as Hurricane Isaac in 2012 and Hurricane Nate in 2017, the *Deepwater Horizon* oil spill and related response activities, and increasing freshwater influence from the Mississippi River. All of these factors combined have severely reduced oyster abundance. As a result, the estimated oyster stock continues to be critically below both the 10-year and long-term averages (*Figure 2.3*).

TABLE 2.1. Comparison of historical and current reef complex acreages in Coastal Study Area 1 South.

Complex Name	Station Name	Station Number	Historical Acreage	Current Acreage
East Black Bay	Jessie's Island	3013	59.0	549.9
	Bayou Lost	3016	118.0	
Bay Gardene	Bay Gardene	3034	69.0	1,262.6
	East Bay Gardene	3033	28.0	
Bay Crabe	West Bay Crabe	3019	501.0	1,732.0
	Bay Crabe	3031	659.0	
	East Bay Crabe	3032	122.0	
Elephant Pass	Elephant Pass	3022	339.0	202.2
California Bay	Sunrise Point	3027	174.0	3,692.8
	California Bay	3025	7.0	
	West Pelican Island	3030	293.0	
	Bay Long	3001	572.0	
Mangrove	Mangrove	3029	937.0	2,889.1
	East Pelican	3028	782.0	
South Black Bay	Stone Island	3020	461.0	3,575.7
	South Black Bay	3021	145.0	
	Curfew Island	3023	425.0	
	North California Bay	3024	109.0	
	Telegraph Island	3026	127.0	
Lonesome Island	Snake Island	3012	506.0	2,861.9
	Lonesome Island Cultch Plant	3086	243.0	
	Lonesome Island	3017	716.0	
	Black Bay	3018	301.0	
Lake Fortuna	Lake Fortuna South	3036	2,144.0	3,453.9
	Lake Fortuna North	3003	2,144.0	
Horseshoe Reef	North Black Bay	3015	157.5	2,485.8
	Horseshoe Reef	3039	157.5	
	East Stone Island	3055	1,138.0	
Wreck	Wreck	3054	1,138.0	4,485.8
Battledore Reef	Battledore Reef	3035	1,419.0	270.6
Lake Fortuna Cultch Plant				300.0
Total			***15,991.0***	***27,762.3***

Spat Production

No live spat were found in the 2018 oyster stock assessment samples. Although these sampling events may occur outside of the peak spawning period, it is evident that there has been only minimal spat catch on these reefs, marking a continuation of poor spat catches within CSA 1 South.

Hydrological Data

Aside from occasional extreme events (oil spills, tropical storms), extended periods of low spring salinities and possibly periods of hypoxia in the summer and fall decrease spawning success and increase risk of mortality, inhibiting oyster production in this area. Past harvest pressure, combined with poor hydrology for oyster production, have largely degraded reef areas to shell hash and mud that is heavily fouled with mussels and other organisms; this lack of suitable substrate to enable spat settlement adds another stressor to the population in this area.

Fouling Organisms

The hooked mussel is a sessile bivalve often associated with oyster reefs that likely competes with oysters for food and settlement surfaces. During the 2018 oyster stock assessment, hooked mussels were present at 17 of the 31 sampling stations and ranged in density from 3.4 to 202.2 individuals per m^2 (*Table 2.3*). Overall, hooked mussel density has increased slightly from the previous assessment even though the mussels were observed at four fewer stations. The

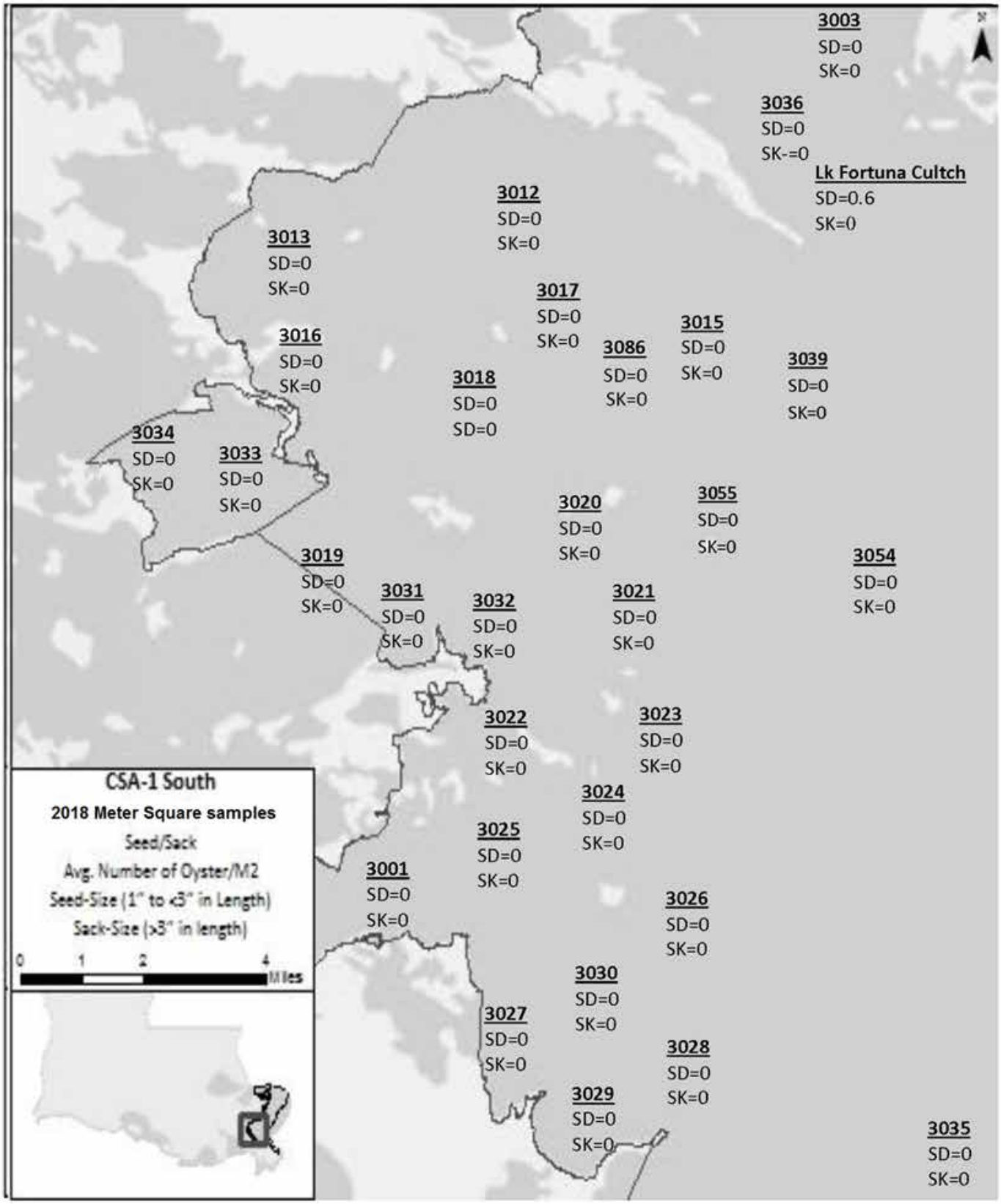

FIGURE 2.1. 2018 Coastal Study Area 1 South oyster stock assessment sampling stations. Numbers below stations are average numbers of seed (SD) and market-size (SK) oysters per m^2.

FIGURE 2.2. Reef complex designations in Coastal Study Area 1 South based on recent water bottom assessments (side-scan sonar).

largest increases in density occurred at the Jessie's Island and Lake Fortuna Cultch Plant sampling stations. Increases in hooked mussel density were observed at 9 of the 31 sampling stations. There were, however, notably large decreases in hooked mussel densities at the South Black Bay and North California Bay sampling stations.

Spionid polychaete mud tubes and fairy lace bryozoans continue to be found on exposed substrate in the assessment area, though not as prevalent as in previous oyster stock assessments. Biologists also noted moderate to heavy barnacle fouling of oyster shells at stations throughout CSA 1 South. All of these forms of fouling appear to be a contributing factor to the limited attachment of oyster larvae to available cultch.

Oyster Predators and Disease

The southern oyster drill is a marine gastropod known to prey on oysters using a small tooth-like scraping organ called a radula to bore a hole through the oyster shell. No live oyster drills were found during this sampling effort. Recent extended periods of low salinity may have limited oyster drill abundance in the area. No stone crabs or blue crabs were observed in the samples.

Dermo, a protozoan parasite that infects oyster tissue, is known to cause extensive oyster mortalities especially in high salinities and high water temperatures. Dermo samples were attempted at seven sampling stations throughout CSA 1 South. Results of the Dermo tests are presented in Appendix I.

Mortality

During 2018 oyster stock assessment sampling, biologists observed oyster mortality only at the Lake Fortuna Cultch Plant. Seed oyster mortality at this location was 25.0 percent. Note that this was the only station where oyster resource was observed during sampling. There was no spat or market-size mortality noted in the assessment samples. Under normal conditions, this could be interpreted as a sign of a healthy population with only minimal impacts from disease or predators. In this instance, however, it could be attributed to biologists finding oyster resource at only 1 of the 31 stations sampled. It is important to consider that mortality estimates are often based on an extremely small number of animals.

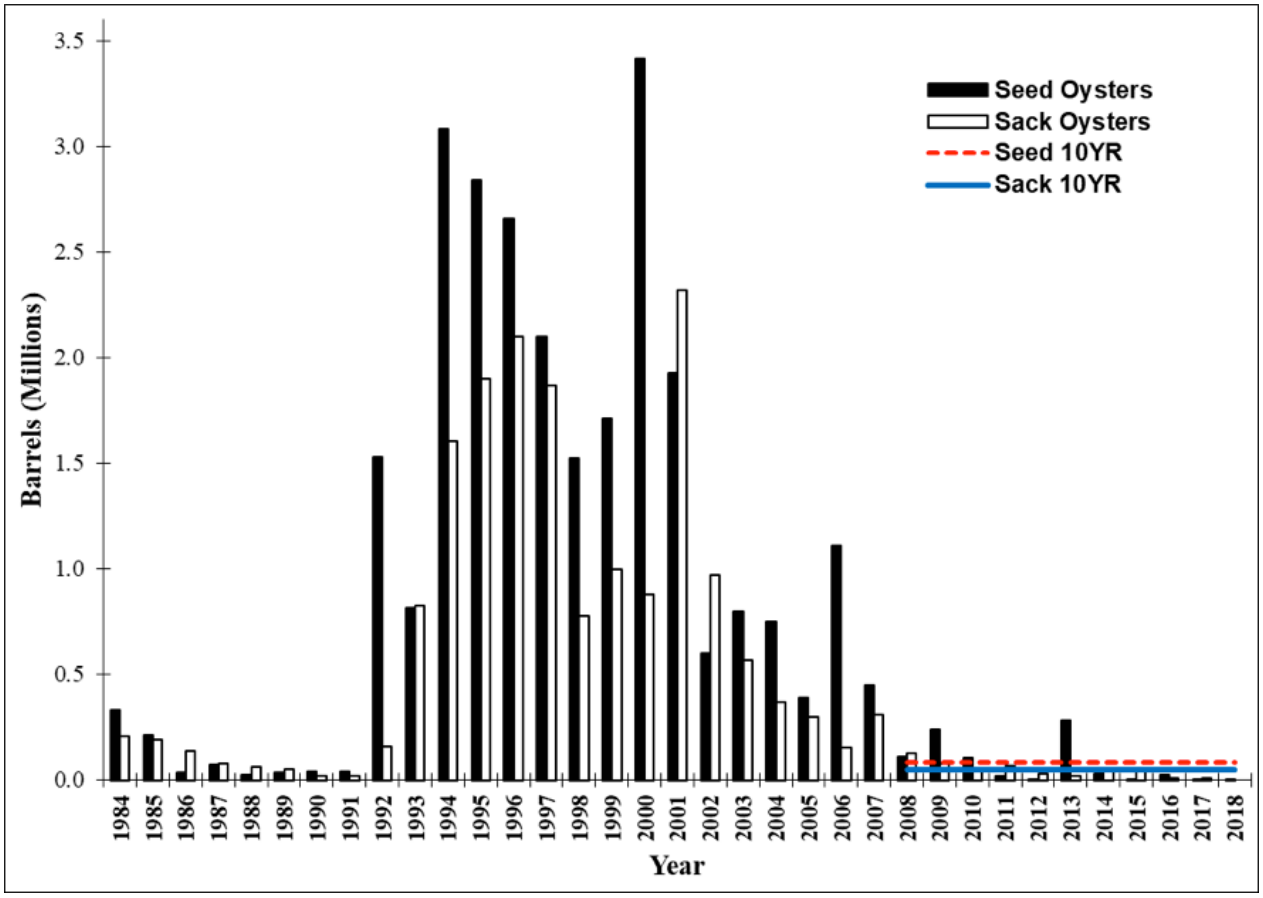

FIGURE 2.3. Current and historical seed and market-size stock size estimates in Coastal Study Area 1 South. Horizontal lines represent the previous 10-years' seed (red) and market-size (blue) stock size estimate averages.

Tropical and Climatic Events

No significant tropical or climatic activity affected CSA 1 South in 2018.

2017/2018 Oyster Season

The 2017/2018 oyster season on the CSA 1 South public oyster seed grounds opened on Nov. 13, 2017. The only area open for commercial harvest during the 2017/2018 oyster season in CSA 1 South was a sacking only area in American Bay (*Figure 2.4*). The statewide 50-sack per day limit was reduced to 25 sacks per day on Nov. 28, 2017. All other public oyster seed grounds south of MRGO remained closed due to historically low stock size estimates observed for a third consecutive annual oyster stock assessment. The 2017/2018 oyster season on the CSA 1 South public oyster seed grounds closed on April 30, 2018.

Harvest Results and Discussion

No commercial harvest of oyster was observed in CSA 1 South during the 2017/2018 season. The American Bay sacking only area was the only public oyster seed ground made available for harvest during this season. Current law mandates that LDWF designate one or more areas east of the Mississippi River for sacking only and that one of the designated areas must be located in the American Bay area east of the Mississippi River (LA R.S. 56 §433.B.2). The 2018 oyster stock assessment estimated there were little to no market-size oysters found on this reef.

TABLE 2.2. Mean density of oysters collected at each sampling station in Coastal Study Area 1 South (bbls = barrels).

Station Name	Station Number	Mean Density			Bbls of Seed Oysters	Bbls of Market-Size Oysters
		Spat	Seed	Market-Size		
Jessie's Island	3013	0.0	0.0	0.0	0.0	0.0
Bayou Lost	3016	0.0	0.0	0.0		
Bay Gardene	3034	0.0	0.0	0.0	0.0	0.0
East Bay Gardene	3033	0.0	0.0	0.0		
West Bay Crabe	3019	0.0	0.0	0.0	0.0	0.0
Bay Crabe	3031	0.0	0.0	0.0		
East Bay Crabe	3032	0.0	0.0	0.0		
Elephant Pass	3022	0.0	0.0	0.0	0.0	0.0
Sunrise Point	3027	0.0	0.0	0.0	0.0	0.0
California Bay	3025	0.0	0.0	0.0		
West Pelican Island	3030	0.0	0.0	0.0		
Bay Long	3001	0.0	0.0	0.0		
Mangrove	3029	0.0	0.0	0.0	0.0	0.0
East Pelican	3028	0.0	0.0	0.0		
Stone Island	3020	0.0	0.0	0.0	0.0	0.0
South Black Bay	3021	0.0	0.0	0.0		
Curfew Island	3023	0.0	0.0	0.0		
North California Bay	3024	0.0	0.0	0.0		
Telegraph Island	3026	0.0	0.0	0.0		
Snake Island	3012	0.0	0.0	0.0	0.0	0.0
Lonesome Island Cultch Plant	3086	0.0	0.0	0.0		
Lonesome Island	3017	0.0	0.0	0.0		
Black Bay	3018	0.0	0.0	0.0		
Lake Fortuna South	3036	0.0	0.0	0.0	0.0	0.0
Lake Fortuna North	3003	0.0	0.0	0.0		
North Black Bay	3015	0.0	0.0	0.0	0.0	0.0
Horseshoe Reef	3039	0.0	0.0	0.0		
East Stone Island	3055	0.0	0.0	0.0		
Wreck	3054	0.0	0.0	0.0	0.0	0.0
Battledore Reef	3035	0.0	0.0	0.0	0.0	0.0
Lake Fortuna Cultch Plant		0.0	0.6	0.0	674.5	0.0
2018 Total					***674.5***	***0/0***

TABLE 2.3. Mean density of hooked mussels and southern oyster drills at each sampling station in Coastal Study Area 1 South.

Complex Name	Station Name	Hooked Mussel Density/m²	Southern Oyster Drill Density/m²
East Black Bay	Jessie's Island	202.2	0.0
	Bayou Lost	0.0	0.0
Bay Gardene	Bay Gardene	4.4	0.0
	East Bay Gardene	12.6	0.0
Bay Crabe	West Bay Crabe	0.0	0.0
	Bay Crabe	0.0	0.0
	East Bay Crabe	0.0	0.0
Elephant Pass	Elephant Pass	86.8	0.0
California Bay	Sunrise Point	0.0	0.0
	California Bay	0.0	0.0
	West Pelican Island	0.0	0.0
	Bay Long	14.8	0.0
Mangrove	Mangrove	0.0	0.0
	East Pelican	32.8	0.0
South Black Bay	Stone Island	48.8	0.0
	South Black Bay	0.0	0.0
	Curfew Island	105.0	0.0
	North California Bay	0.0	0.0
	Telegraph Island	0.0	0.0
Lonesome Island	Snake Island	3.4	0.0
	Lonesome Island Cultch Plant	0.0	0.0
	Lonesome Island	4.4	0.0
	Black Bay	4.4	0.0
Lake Fortuna	Lake Fortuna South	0.0	0.0
	Lake Fortuna North	9.6	0.0
Horseshoe Reef	North Black Bay	0.0	0.0
	Horseshoe Reef	9.6	0.0
	East Stone Island	13.2	0.0
Wreck	Wreck	20.4	0.0
Battledore Reef	Battledore Reef	5.8	0.0
Lake Fortuna	Lake Fortuna Cultch Plant	166.2	0.0

CSA 3

Introduction

CCSA 3 consists of three public oyster areas distributed generally in a north-south direction within the Barataria Bay estuary:

1. Hackberry Bay Public Oyster Seed Reservation
2. Barataria Bay Public Oyster Seed Grounds
3. Little Lake Public Oyster Seed Grounds.

Hackberry Bay is the oldest of the three; the Legislature designated this area as a public oyster seed reservation in 1944. The Commission designated Barataria Bay and Little Lake as public oyster seed grounds in 2000 and 2007, respectively. Historically, LDWF has monitored three sampling stations, all in Hackberry Bay, for the annual oyster stock assessment in CSA 3. However, LDWF has expanded sampling in recent years with the addition of the Barataria Bay Public Oyster Seed Grounds and newly constructed oyster reefs in Hackberry Bay.

Hackberry Bay, in Jefferson and Lafourche parishes, is a 4,402-acre mesohaline embayment with a primarily soft silt and clay bottom, of which only 14.7 acres is naturally occurring reef material. The three historical sampling stations within Hackberry Bay are the Upper, Middle, and Lower Hackberry Bay sampling stations. The Middle Hackberry Bay station is the only station located over existing natural reef, while the Upper and Lower stations are located over former cultch plants placed on top of historical reefs. The Upper Hackberry Bay station was the result of a 1994 cultch plant using federal disaster funds from Hurricane Andrew in 1992. The 1994 cultch plant totaled 145 acres and was comprised of six different sections of substrate including: crushed concrete, shucked shell, reef shell, clam shell, Kentucky limestone, and Bahamian limestone. This station was also the location of cultch plants in 1943 (140 acres), 1945 (70 acres), 1946 (92 acres), and 1981 (67 acres). The Lower Hackberry Bay station is on a reef that was part of a 450-acre 1973 cultch plant. Since very little natural reef exists on the Hackberry Bay Public Oyster Seed Reservation, production is highly dependent upon and reflective of when and where cultch plants are placed in the bay. It is unknown how much, if any, cultch material from the 1994 and earlier cultch plants remains exposed above the surface of the mud. Therefore, the acreage of these previous cultch plants is not factored into the annual oyster stock assessment.

Since 2004, LDWF has constructed five cultch plants in Hackberry Bay. LDWF constructed two cultch plants totaling 35 acres in 2004 and one totaling 50 acres in 2008. Two additional plants, a 2012 plant of approximately 200 acres, and a 2014 plant of 30 acres, combined with the other three, have increased the estimated reef acreage on the Hackberry Bay. These recent cultch plants have increased the estimated reef acreage on the Hackberry Bay Public Oyster Seed Reservation from 99.7 to 329.7 acres.

The Commission designated the Barataria Bay Public Oyster Seed Grounds as such in response to possible changes in the salinity regime of the estuary stemming from the Davis Pond freshwater diversion project. Davis Pond is a large Mississippi River diversion that aims to reintroduce freshwater and nutrients into the Barataria Bay estuary to help restore the Louisiana coast. As this diversion was anticipated to reduce salinities in the estuary, LDWF estimated that additional public oyster seed grounds farther down-estuary may be productive during years with high freshwater input. The only known existing reef on the Barataria Bay Public Oyster Seed Grounds is a 40-acre cultch plant constructed of 7,536 cubic yards of crushed concrete in the northeast section of the area in May 2004. The reef is vulnerable to predators such as oyster drills and the protozoan parasite Dermo during periods of higher salinities. LDWF does not expect consistent production from this area until salinity regimes in the basin change due to natural forces or coastal restoration efforts.

The Little Lake Public Oyster Seed Grounds had previously been used as a temporary natural reef area and once contained private oyster leases. These leases all fell within the Davis Pond freshwater diversion impact area and were either purchased or moved by the state and federal government prior to the opening of the Davis Pond diversion. The Davis Pond diversion has not been consistently used to its maximum capacity since it first opened in 2002, and environmental conditions during some years have allowed oysters to continue to exist in Little Lake. Therefore, the Commission designated this area a public oyster ground so fishermen could harvest oysters from this area and LDWF could actively manage the reefs in this area. The location of the Little Lake Public Oyster Seed Grounds makes it vulnerable to depressed salinities from rainfall, inflow from the Intracoastal Waterway, and discharge from the Davis Pond diversion. Reduced salinities from increased freshwater input can negatively impact oyster survival and availability. However, when salinities are higher, the Little Lake Public Oyster Seed Grounds have provided the oyster industry with additional seed and market-size oysters in Barataria Basin. Although there is no information on the reef acreage on the Little Lake Public Oyster Seed Grounds, LDWF hopes to better survey the area in the future.

Methods

LDWF biologists collected field samples for the 2018 oyster stock assessment between June 28 and July 6, 2018 from a total of nine stations within CSA 3 according to the methodology described in the Statewide Overview of this report. Sampling stations included the recent cultch plants in Hackberry Bay (2012 and 2014; *Figure 3.1*). Biologists did not sample the Little Lake Public Oyster Seed Grounds due to lack of information on reef acreage.

FIGURE 3.1. 2018 Coastal Study Area 3 sampling results as an average per square meter (SP = spat, SD = seed, SK = sack (market-size), and M = mortality percentage).

TABLE 3.1. 2018 square-meter sampling results for Coastal Study Area 3.

Station Name	Station Number	Approx. Reef Acreage	Average Live Seed Oysters/ m^2	Average Live Market-Size Oysters/m^2	Bbls of Seed Oysters Available	Bbls of Market-Size Oysters Available	Oysters Spat/m^2
2004 Hackberry Bay North Cultch Plant	6	10.0	0.0	0.0	0.0	0.0	0.0
2004 Hackberry Bay South Cultch Plant	7	25.0	0.0	0.0	0.0	0.0	0.0
2008 Hackberry Bay Cultch Plant	9	50.0	1.0	0.2	281.0	112.4	0.0
2012 Hackberry Bay Cultch Plant	10	200.0	0.8	0.4	899.3	899.3	0.0
2014 Hackberry Bay Cultch Plant	11	30.0	4.8	1.0	809.4	337.2	0.0
Lower Hackberry Bay	1	4.9	0.0	0.0	0.0	0.0	0.0
Middle Hackberry Bay	2	4.9	0.4	1.4	11.0	77.1	0.0
Upper Hackberry Bay	3	4.9	1.2	0.6	33.0	33.0	0.0
2004 Barataria Bay Cultch Plant	8	40.0	0.2	0.0	45.0	0.0	0.0
Little Lake		Unknown	Unknown	Unknown	Unknown	Unknown	
Total		***369.7***			***2,078.7***	***1,459.1***	

Results and Discussion

Seed and Market-Size Stock

The 2018 oyster stock assessment estimated the stock on the Hackberry Bay Public Oyster Seed Reservation, including the productive cultch plants, at 2,078.7 bbls of seed oysters and 1,459.1 bbls of market-size oysters for a total of 3,537.8 bbls of overall stock (*Table 3.1*). Seed oysters were not present at the Lower Hackberry Bay and 2004 Hackberry Bay North and South cultch plant stations. There was an overall 42.6 percent decrease in seed availability from July 2017. Seed availability is 83.1 percent below the 10-year average (12,045.3 bbls) and 85.1 percent below the longterm average from 1976-2017 (13,661.2 bbls). Market-size oysters were present at all stations, except Lower Hackberry Bay and 2004 Hackberry Bay North and South and 2004 Barataria Bay cultch plants. Middle Hackberry Bay was the only station that had more market-size oysters available compared to 2017 (0.2 per m^2); this station also had the highest density of market-size oysters at 1.4 per m^2 (*Table 3.1*). Including the 2012 and 2014 Hackberry Bay cultch plants, the market-size oyster stock was down 72.8 percent from 2017, 71.9 percent from the 10-year average (5,182.6 bbls), and 80.3 percent from the long-term average (7,413.6 bbls; *Figure 3.2*). The combined stock of 3,492.9 bbls of seed and market-size oysters was 61.0 percent below the 2017 estimate (8,902 bbls), 79.7 percent below the 10-year average (17,227.8 bbls), and 83.4 percent below the longterm average (21,074.8 bbls). There was an overall reduction in market-size oyster stock at all but one station, Middle Hackberry Bay. The highest available bbls of market-size oysters were at the 2008, 2012, and 2014 Hackberry Bay cultch plants. There were 899.3 bbls of seed oysters available at the 2012 Hackberry Bay Cultch Plant and 809.4 bbls available at the 2014 Hackberry Bay Cultch Plant. The progressive decline in available oyster stock over time appears to be an artifact of loss of production on ageing reefs within the Hackberry Bay Public Oyster Seed Reservation. Researching the potential for rehabilitating older reefs and cultch plants should be considered to augment production.

	2017	2018	% Change
Seed	3,540.8	2,078.7	-41.3
Market-Size	5,361.0	1,459.1	-72.8
Total	*8,901.8*	*3,537.9*	*-60.3*

The July 2018 average size of seed and market-size oysters was 2.4 inches (*Figures 3.3 and 3.4*). The overall average size, from combined dredge and square-meter samples, from July 2017 to July 2018 was 2.4 inches, ranging from 1.6 to 2.9 inches (*Figure 3.4*). One seed oyster was sampled on the Barataria Bay Public Oyster Seed Grounds (*Figure 3.1, Table 3.1*). Market-size oyster availability has not been documented on the Barataria Bay Public Oyster Seed Grounds since it was created in 2004. The July 2018 average catch-per-unit-effort (CPUE) at the seven Hackberry Bay stations, for both seed and market-size oysters combined, as well as spat, seed, and market-size oysters combined, was lower than July 2017, and the CPUE was below the overall combined monthly average CPUE for dredge samples from August 2017 through June 2018 (*Figure 3.5*).

Spat Production

There were fewer spat per m^2 compared to 2017 (0.0 spat per m^2 vs. 1.5 spat per m^2). No live or dead spat were collected in 2018. Spat abundance was well below the long-term average of 8.4 spat per m^2. Since the Barataria Bay Public Oyster Seed Grounds were

established, the only stock assessment samples on this area with a record of spat were in 2005 (8 spat per m^2), 2009 (53.5 spat per m^2), 2010 (5.2 spat per m^2), and 2013 (2.6 spat per m^2).

Hydrological Data

The United States Army Corps of Engineers (USACE) Tarbert gauge recorded Mississippi River discharge from January 2017 through June 2018 as averaging 578,800 cubic feet per second (cfs), below the long-term average (1961-2017) of 594,000 cfs and reaching a peak discharge for 2018 at 1,251,000 cfs in March. Discharge levels remained above the long-term average through April and May prior to LDWF's sampling efforts in July 2018 (*Figure 3.6*).

The United States Geologic Survey (USGS) constant data recorder, located near the Davis Pond diversion structure, recorded a monthly average discharge of 1,301 cfs from July 2017 through June 2018, which was below the longterm monthly average of 1,769 cfs. The maximum monthly average discharge over this time period was 3,775 cfs during March (*Figure 3.7*).

Hackberry Bay Public Oyster Seed Reservation salinities from January 2017 to June 2018 averaged 10.1 ppt with a range of 2.2 to 17.4 ppt (*Figures 3.6, 3.7, and 3.8*). The average salinity for June 2018 was 9.6 ppt, which remained above the June long-term monthly average (1996-2017) of 8.9 ppt. Monthly average salinities for the Hackberry Bay Public Oyster Seed Reservation have been above the longterm monthly average since April.

Using the Habitat Suitability Index (HSI) model from oystersentinel.org, the average salinity values listed above, along with a potential 100 percent bottom covered with suitable cultch, yielded only an HSI value of 0.43 or "Fair" oyster habitat for Hackberry Bay Public Oyster Seed Reservation in 2018. The HSI value for Hackberry Bay was 0.00 from 2015 through 2017 and has been categorized as "Unsuitable" for the past four years, mostly because of suppressed salinity levels. Lower Mississippi River discharge, combined with decreased discharge from the Davis Pond structure, and near-average rainfall over the previous four months, elevated salinity in Hackberry to above the long-term monthly average. The fair oyster habitat conditions over a longer period of time have likely promoted some rebound in the oyster population within the Hackberry Bay Public Oyster Seed Reservation leading to the more stable CPUE values seen during 2018 sampling.

Salinities in the Barataria Bay Public Oyster Seed Grounds from January 2017 to June 2018 averaged 17.0 ppt with a range of 6.8 to 28.4 ppt (*Figure 3.9*). Using the HSI model, the average salinity values listed above, along with a potential 100 percent bottom covered with suitable cultch, yielded an HSI value of 0.70 or "Good Habitat" for the Barataria Bay Public Oyster Seed Grounds. Therefore, it would be expected that some level of oyster stock would be available on this area. One seed oyster was sampled for the first time since development of the reef in 2004. While conducting complementary dive samples near the Barataria Bay Public Oyster Seed Grounds for work ancillary to the stock assessment, biologists sampled live spat, seed, and market-size oysters in May 2018.

Salinities in the Little Lake Public Oyster Seed Grounds from January 2017 to June 2018 averaged 5.5 ppt with a range of 0.4 to 12.2 ppt (*Figures 3.8 and 3.9*). Using the HSI model, the average salinity values listed above, along with a potential 100 percent bottom covered with suitable cultch, yielded an HSI value of 0.00 or "Unsuitable Habitat" for the Little Lake Public Oyster Seed Grounds. This HSI value likely explains the high mortalities and low catch effort seen for the replicate dredge samples conducted in Little Lake Public Oyster Seed Grounds during July 2018.

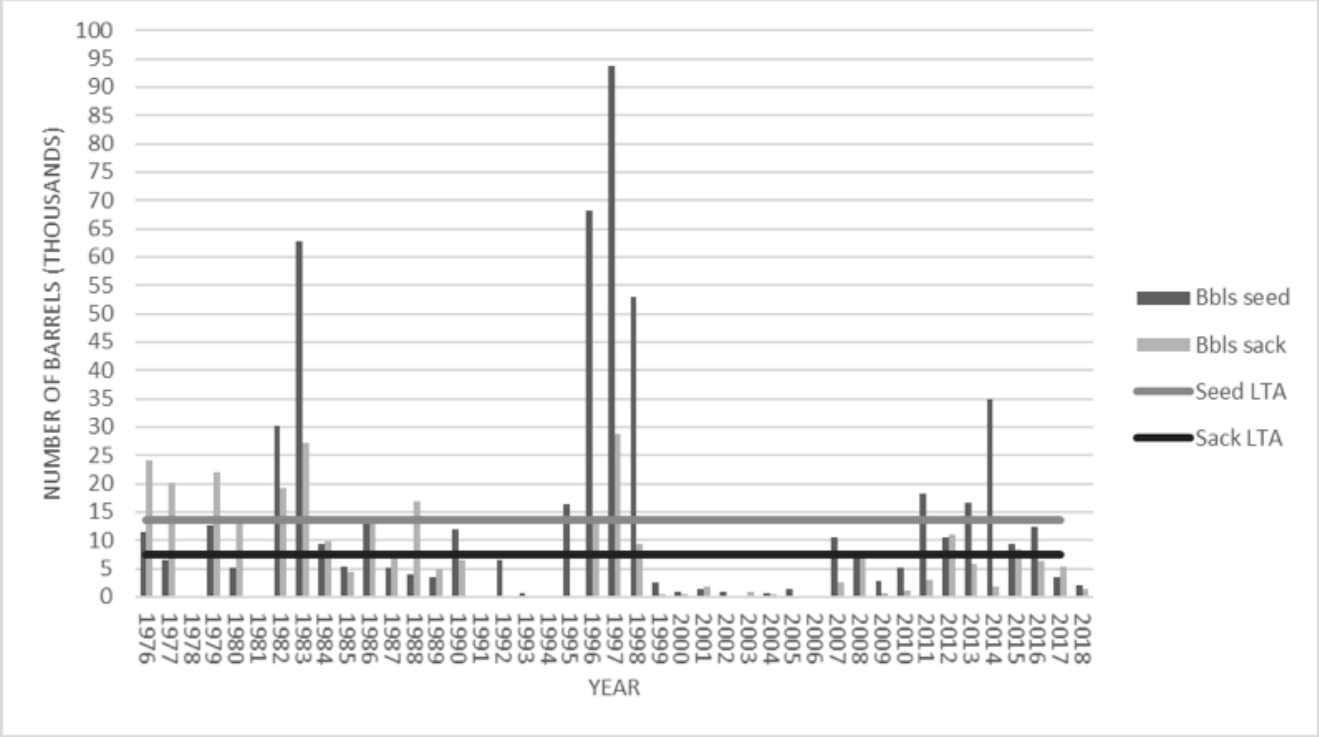

FIGURE 3.2. Estimated seed and market-size oyster availability on the Hackberry Bay Public Oyster Seed Reservation from 1976 to 2018 compared to long-term average seed and market-size abundance.

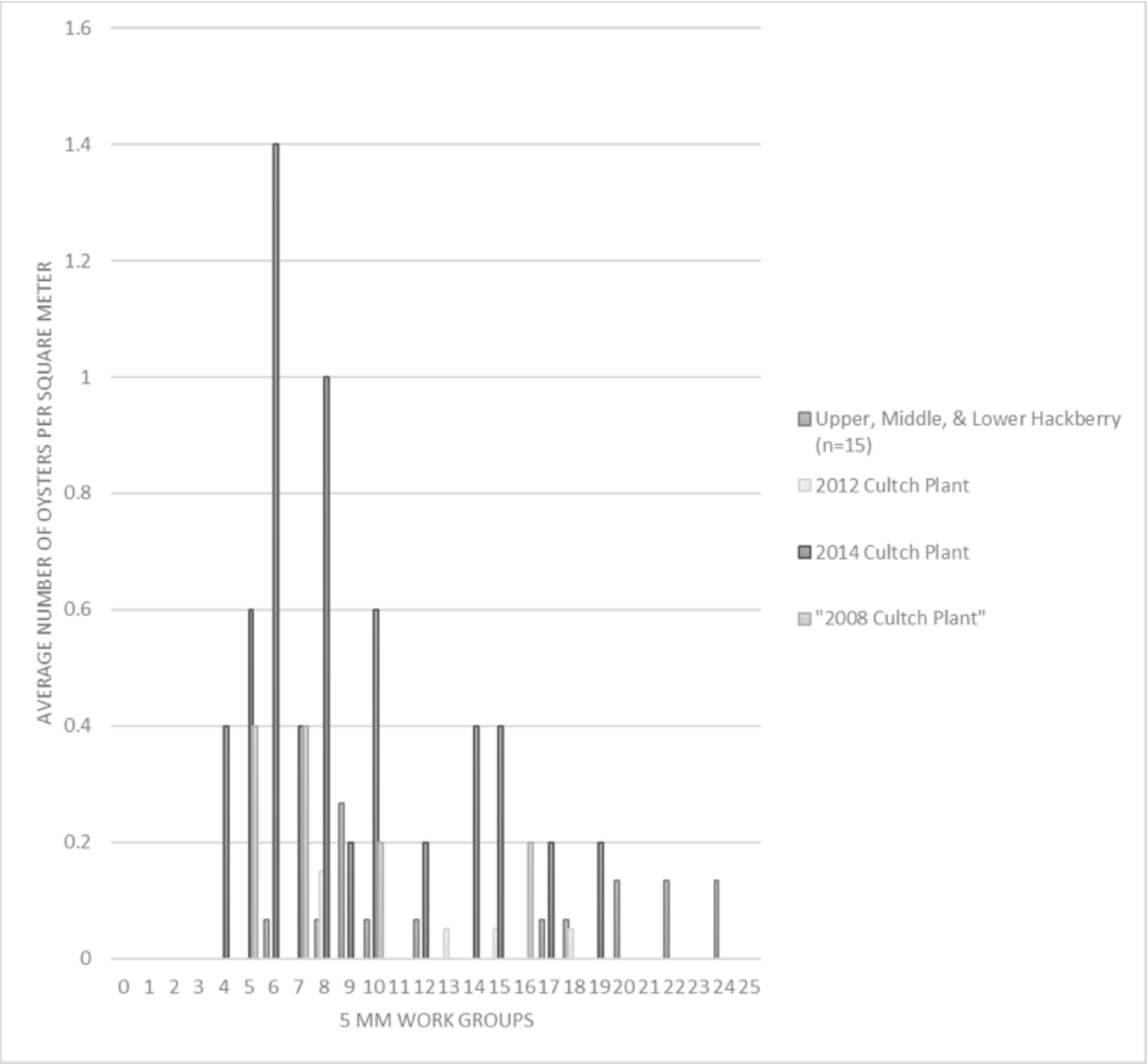

FIGURE 3.3. Oyster size distribution by 5-millimeter work groups in square-meter samples collected from the Hackberry Bay Public Oyster Seed Reservation during 2018, illustrating that the majority of seed and market-size oysters came from the 2014 cultch plant.

Fouling Organisms

The hooked mussel is a reef-associated, benthic bivalve species that competes with oysters for food and settlement surfaces. Hooked mussels were present at five of the nine sampling stations including Middle and Upper Hackberry Bay as well as the 2004 Hackberry Bay South, 2012 Hackberry Bay, and 2014 Hackberry Bay cultch plants. The highest density (72.2 mussels per m^2) was observed at the 2014 Hackberry Bay Cultch Plant (*Table 3.2*). The average number of hooked mussels observed on the Hackberry Bay Public Oyster Seed Reservation was 15.2 per m^2, an increase from 2017 (3.1 per m^2). The average salinity for the Hackberry Bay Public Oyster Seed Reservation in June 2018 was 9.6 ppt, above the long-term average salinity for June of 8.9 ppt (*Figure 3.6*). The previous four years' June salinities on the Hackberry Bay Public Oyster Seed Reservation have been well below the area's long-term average.

Oyster Predators and Disease

The southern oyster drill is a marine snail that preys on oysters using a radula (a small tooth-like rasping organ) to bore a hole through the oyster shell. During sampling for the 2018 oyster stock assessment, no oyster drills were collected from the Barataria Bay Public Oyster Seed Grounds. Since 2009, biologists have collected only 21 oyster drills during dredge and square-meter sampling; most of these have come from the Barataria Bay Public Oyster Seed Grounds. Mortalities of oyster drills have been reported from Mississippi Sound when salinities fell below 8 to 10 ppt; the absence of oyster drills from almost all 2018 samples is most likely due to the low overall average salinities throughout CSA 3.

Dermo, a protozoan parasite that infects live oyster tissue, is known to cause extensive oyster mortalities especially in high salinities and water temperatures. Results of Dermo tests are presented in Appendix I.

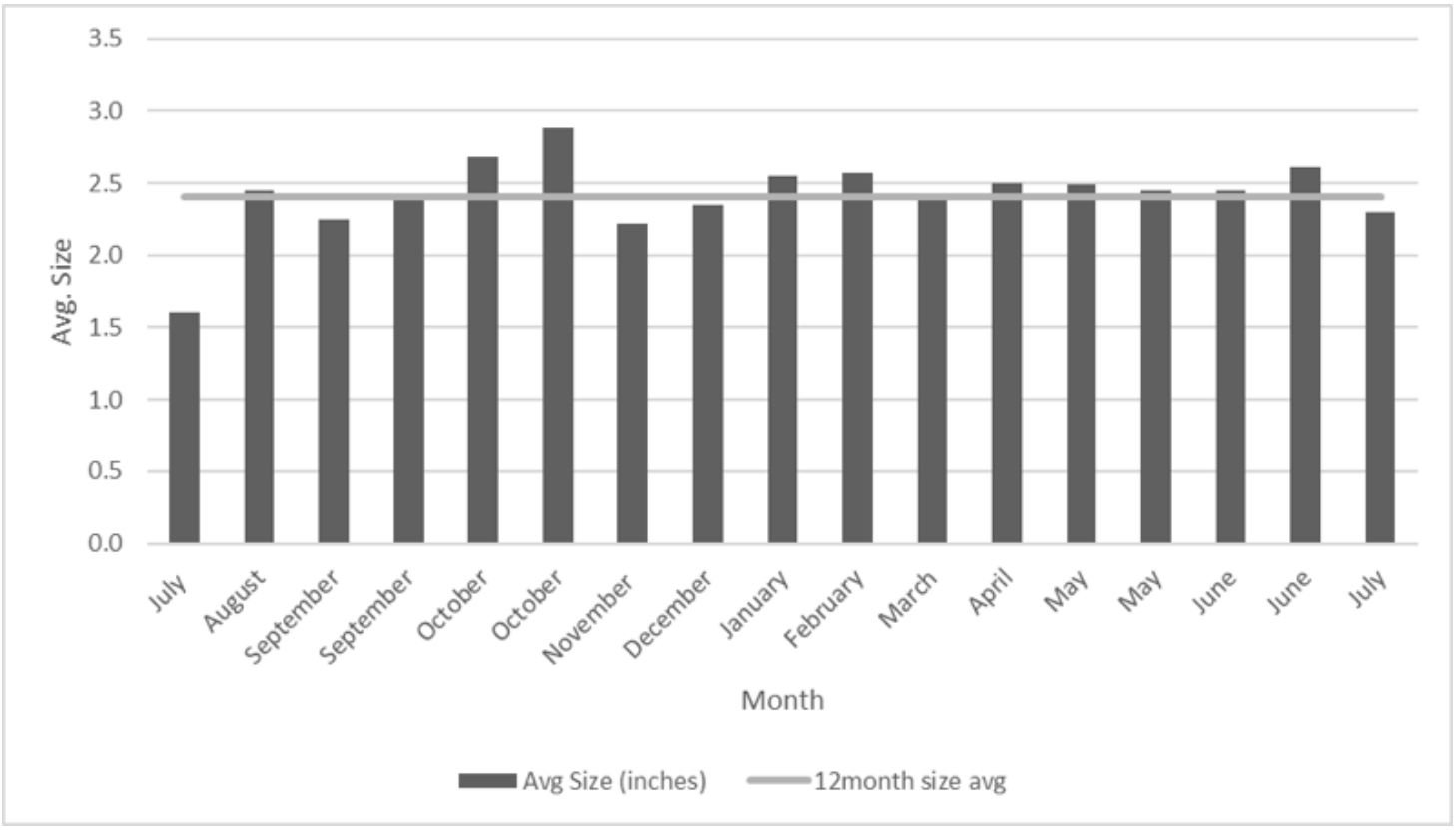

FIGURE 3.4. Monthly average oyster size for dredge and square-meter samples from July 2017 to July 2018 in Coastal Study Area 3.

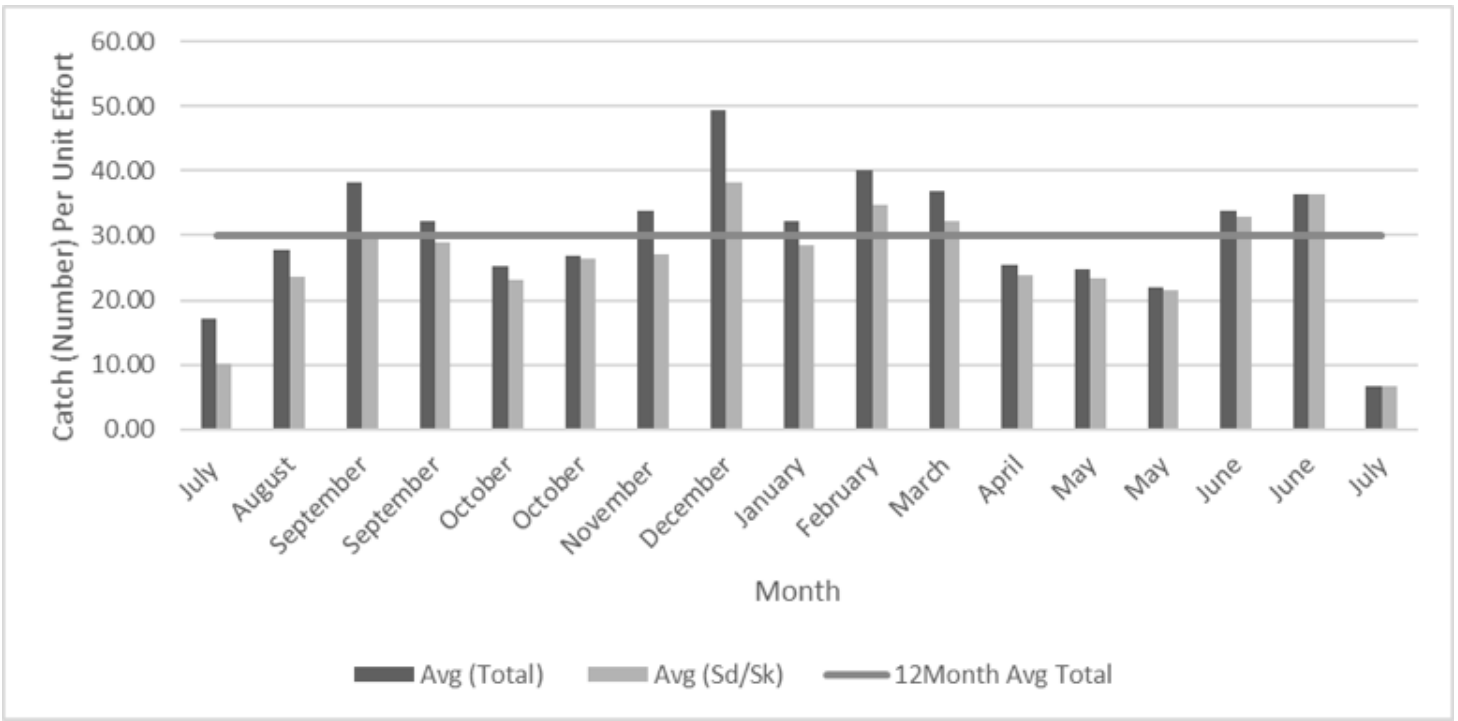

FIGURE 3.5. Monthly catch-per-unit-effort (CPUE) for two replicate dredge samples taken at seven Hackberry Bay stations combined per month. July CPUE was based on square-meter samples and excluded the Barataria Bay Cultch Plant.

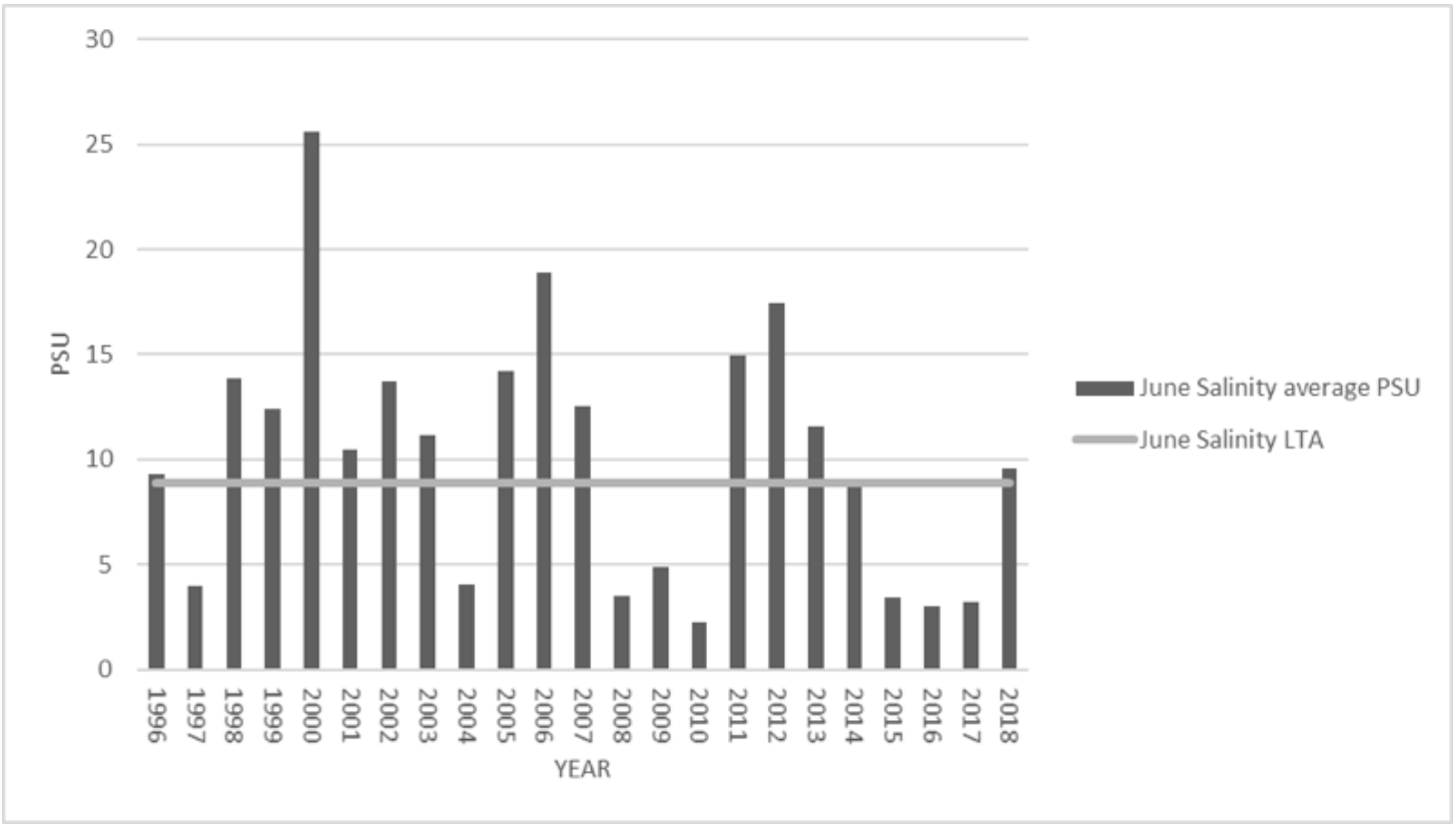

FIGURE 3.6. Historical annual and long-term average monthly salinities for June in Hackberry Bay from 1996 to 2018. Data supplied by the U.S. Geological Survey constant data recorder located in Hackberry Bay.

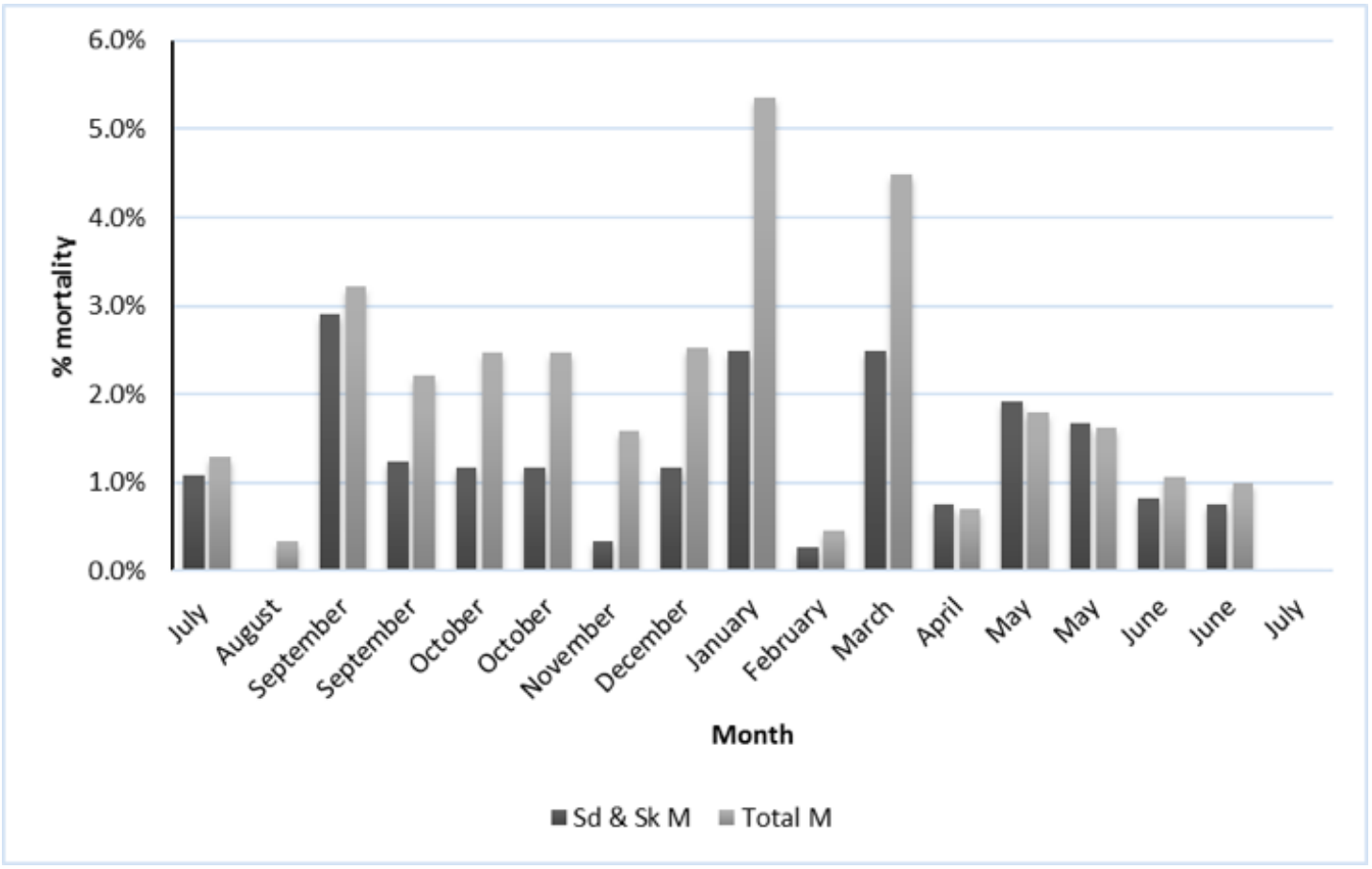

FIGURE 3.7. Total oyster (Total M) and combined seed/market-size (Sd & Sk M) mortality in Coastal Study Area 3.

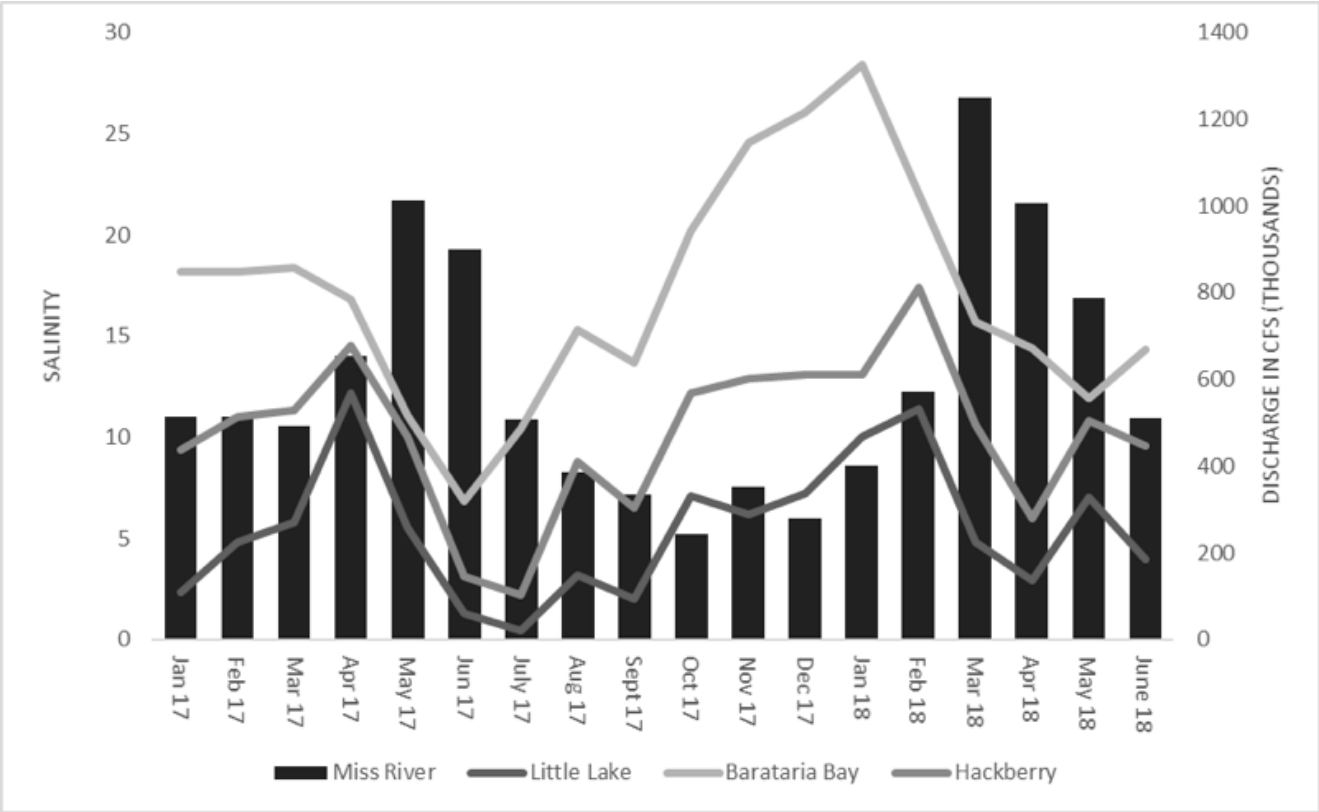

FIGURE 3.8. Mississippi River discharge vs. average monthly salinities in the Barataria Bay and Little Lake public oyster seed grounds and Hackberry Bay Public Oyster Seed Reservation. The U.S. Army Corps of Engineers supplied Mississippi River discharge data.

Mortality

Recent spat mortality at each sampling station on the Hackberry Bay Public Oyster Seed Reservation averaged 0.0 percent overall, a decrease from the 1.6 percent overall average in 2017. Recent seed and market-size oyster mortality at each station also averaged 0.0 percent. Recent market-size oyster mortality was 0.0 percent (*Table 3.2, Figure 3.7*). No spat was observed on the Barataria Bay Public Oyster Seed Grounds. One live seed oyster and one dead seed oyster were sampled on the Barataria Bay Public Oyster Seed Grounds producing a 50 percent mortality rate for seed oysters.

Since the 2017 oyster stock assessment, monthly dredge samples have provided additional sources of oyster mortality data. Dredge samples revealed an overall combined spat, seed, and market-size average monthly mortality of 2.1 percent between August 2017 and June 2018 (*Figure 3.7*). This was similar to the 2.6 percent overall monthly mortality observed during the same time period prior to the 2017 oyster stock assessment sampling. Although the average monthly mortality for the past 12 months appears low, elevated spat mortalities were documented in January and June 2018.

Tropical and Climatic Events

Tropical Storm Cindy was the first tropical cyclone to make landfall in Louisiana since Hurricane Isaac in 2012. Cindy weakened slightly prior to making landfall in southwestern Louisiana on June 22, 2017, and only affected CSA 3 with above normal tides for 24 hours. On Oct. 8, 2017, Hurricane Nate made landfall near the mouth of the Mississippi River in Louisiana and headed inland across Mississippi. Nate was the fastest-moving tropical system ever recorded in the Gulf of Mexico. The majority of hurricane force winds and associated storm surge were on the eastern side of the Mississippi River and did not affect CSA 3.

2017/2018 Oyster Season

The Little Lake Public Oyster Seed Grounds, Barataria Bay Public Oyster Seed Grounds, and Hackberry Bay Public Oyster Seed Reservation remained closed for the 2017/2018 season.

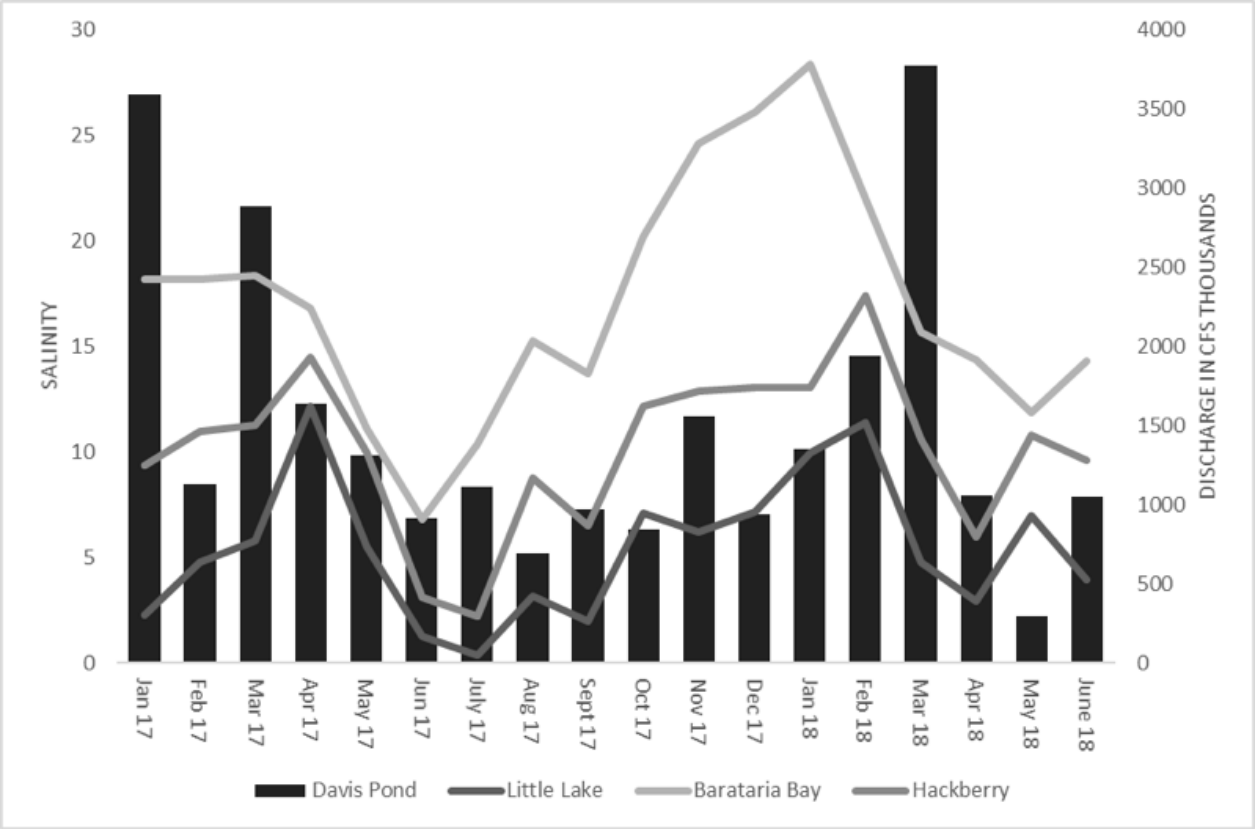

FIGURE 3.9. Davis Pond discharge vs. average monthly salinities in the Barataria Bay and Little Lake public oyster seed grounds and Hackberry Bay Public Oyster Seed Reservation. The Davis Pond discharge data are supplied by the U.S. Geological Survey constant data recorder located near the Davis Pond structure.

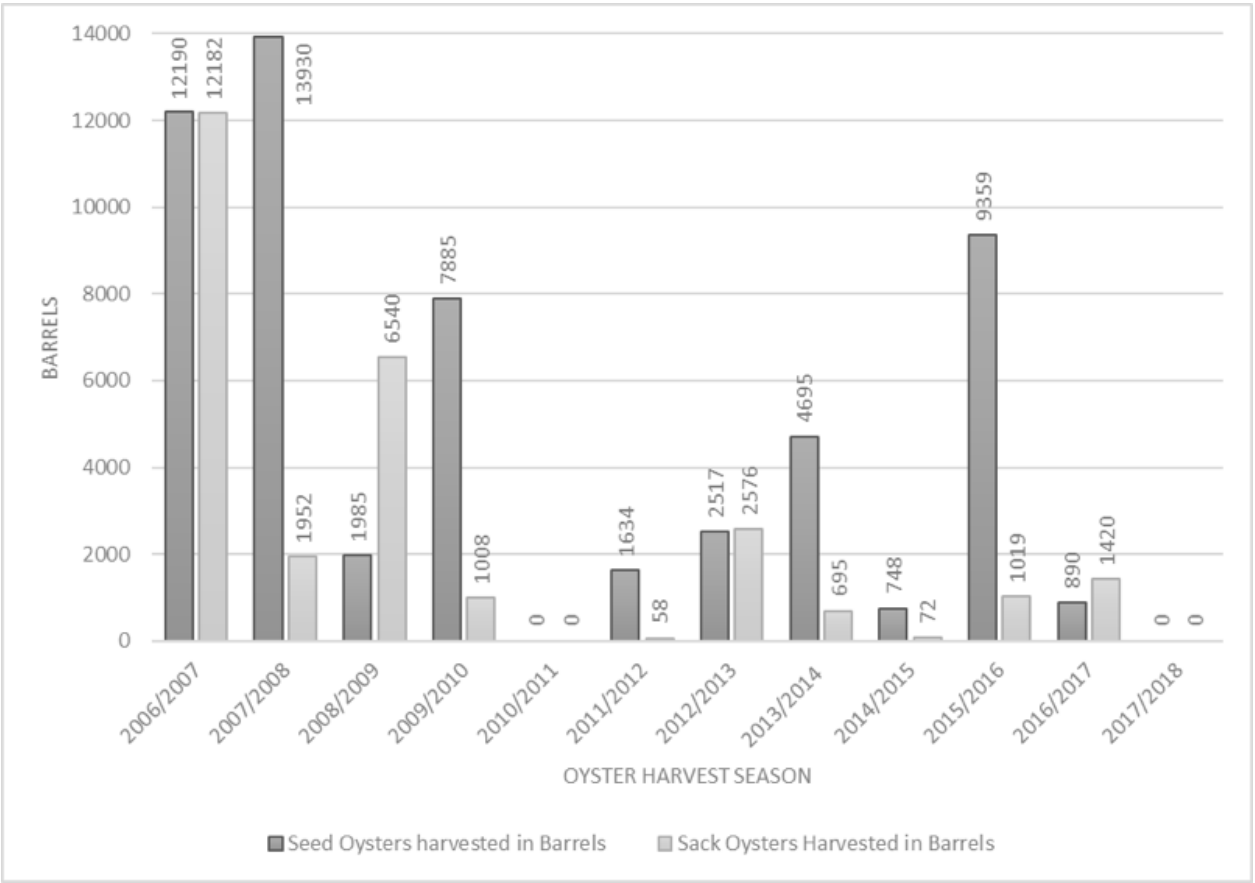

FIGURE 3.10. Estimated oyster harvest from the public oyster areas in Coastal Study Area (CSA) 3 for the past 10 oyster seasons based on boarding surveys. 2014/2015 estimates are for the Little Lake Public Oyster Seed Grounds only. There was no harvest in 2017/2018 due to all public oyster areas in CSA 3 being closed.

TABLE 3.2. 2018 square-meter sampling predator/mortality results for Coastal Study Area 3.

Station Name	Station Number	Hooked Mussels/m²	Oyster Drills Present	Spat % Mortality	Seed % Mortality	Market-Size % Mortality	Seed and Market-Size % Mortality	All Size % Mortality
2004 Hackberry Bay North Cultch Plant	6	0	0	0.0	0.0	0.0	0.0	0.0
2004 Hackberry Bay South Cultch Plant	7	0	0	0.0	0.0	0.0	0.0	0.0
2008 Hackberry Bay Cultch Plant	9	0	0	0.0	0.0	0.0	0.0	0.0
2012 Hackberry Bay Cultch Plant	10	30	0	0.0	0.0	0.0	0.0	0.0
2014 Hackberry Bay Cultch Plant	11	72	0	0.0	0.0	0.0	0.0	4.9
Lower Hackberry Bay	1	0	0	0.0	0.0	0.0	0.0	0.0
Middle Hackberry Bay	2	17	0	0.0	0.0	0.0	0.0	0.0
Upper Hackberry Bay	3	18	0	0.0	0.0	0.0	0.0	0.0
2004 Barataria Bay Cultch Plant	8	0	0	0.0	0.0	0.0	N/A	N/A
Little Lake		N/A						

CSA 5

Introduction

CSA 5 is comprised of the Terrebonne Basin from Bayou Lafourche west to the Atchafalaya River, including Terrebonne Bay, Timbalier Bay, Sister Lake, Lake Mechant, and Caillou Bay. CSA 5 oyster stock assessments are divided into eastern and western portions of the Terrebonne Basin.

There are currently seven different public oyster seed reservations and grounds within CSA 5:

1. Sister Lake (Caillou Lake) Public Oyster Seed Reservation
2. Bay Junop Public Oyster Seed Reservation
3. Lake Mechant Public Oyster Seed Grounds
4. Deep Lake Public Oyster Seed Grounds
5. Lake Felicity Public Oyster Seed Grounds
6. Lake Chien Public Oyster Seed Grounds
7. Lake Tambour Public Oyster Seed Grounds.

Sister Lake, Bay Junop, and Lake Mechant are located in the western Terrebonne Basin; Deep Lake, Lake Felicity, Lake Chien, and Lake Tambour are found in the eastern Terrebonne Basin (*Figures 5.1 and 5.2*).

The Commission designated Sister Lake (*Figure 5.1*) as a public oyster seed reservation in 1940; this area includes 9,150.5 acres of water bottom. The U.S. Bureau of Fisheries established the first known cultch deposition projects in Sister Lake between 1906 and 1909. The State of Louisiana began subsequent plantings in 1917; since then, the State has constructed 21 cultch plants totaling 4,862.5 acres in Sister Lake, with some cultch plants located on top of older ones or on top of existing reef habitat. Recent Sister Lake cultch plants include a 67-acre site in 2004, a 156-acre site in 2009, and a 358-acre site in 2012. The majority of the 2012 cultch plant was placed atop existing reef and made a minimal addition, less than 100 acres, to the total available reef acres in Sister Lake. For oyster stock assessment purposes, the cultch plant was combined with a small amount of adjacent reef acreage; sampling on this cultch plant represents oyster conditions on 364.8 acres of reef. The current total reef acreage for Sister Lake is estimated to be 2,375.36 acres.

The Commission established the Bay Junop Public Oyster Seed Reservation (*Figure 5.1*) in 1948; it consists of approximately 2,646.5 acres of water bottom. Due to the shallow water depth of the bay and inability of barges and tugs to enter for cultch plants, LDWF has not been able to construct any reefs in this area to augment natural oyster reef production. Available public reef acreage in Bay Junop is estimated at approximately 252 acres.

The Commission established the Lake Mechant Public Oyster Seed Grounds (*Figure 5.1*) in 2001 with approximately 2,100 acres of water bottom. In 2004, LDWF constructed a 30-acre cultch plant in this area. In 2007, the Commission added unleased water bottoms between the designated public oyster seed grounds and private oyster leases, increasing water bottom acreage within the Lake Mechant Public Oyster Seed Grounds to 2,583 acres. The total reef acreage outside of the 2004 cultch plant is unknown.

The Commission established the Lake Tambour, Lake Chien, Lake Felicity, and Deep Lake public oyster seed grounds (*Figure 5.2*) in 2001. The upper portion of Lake Felicity was used as a public oyster seed reservation during the 1940s and early 1950s, but this was discontinued because salinities were usually too high for oyster production. However, future planned coastal freshwater diversion projects may return the area to a salinity regime that is more favorable for oyster production.

There are three cultch plants between the Lake Chien and Lake Felicity public oyster seed grounds including a 16-acre cultch plant in Lake Chien completed in the summer of 2004, a 40-acre cultch plant in Lake Felicity completed in the summer of 2004, and a 22-acre cultch plant due east of the initial Lake Chien cultch plant completed in May 2009. Outside of these cultch plants, there is no known reef in between the Lake Chien and Lake Felicity public oyster seed grounds. LDWF has not developed any reefs in Lake Tambour or Deep Lake.

Methods

LDWF biologists collected field samples for the 2018 oyster stock assessment on July 11, 2018 from a total of 19 stations within CSA 5 according to the methodology described in the Statewide Overview of this report. Sampling stations included existing oyster reefs in Lake Felicity, Lake Chien, Sister Lake, Bay Junop, and Lake Mechant.

For the 2013 oyster stock assessment for CSA 5, biologists adjusted acreage in Sister Lake due to the footprint of the 2012 cultch plant and the combination of stations on overlapping reefs. They have maintained this adjustment for all assessments since then. There are additional details on stations and reef complexes affected in the 2013 Oyster Stock Assessment Report.

Results and Discussion

Seed and Market-Size Stock

The 2018 oyster stock assessment estimated the stock for CSA 5 at 48,358 bbls of seed oysters and 22,146 bbls of market-size oysters in the western basin, and 452 bbls of seed oysters and 0 bbls of market-size oysters in the eastern basin (*Tables 5.1-5.4; Figures 5.3-5.5*).

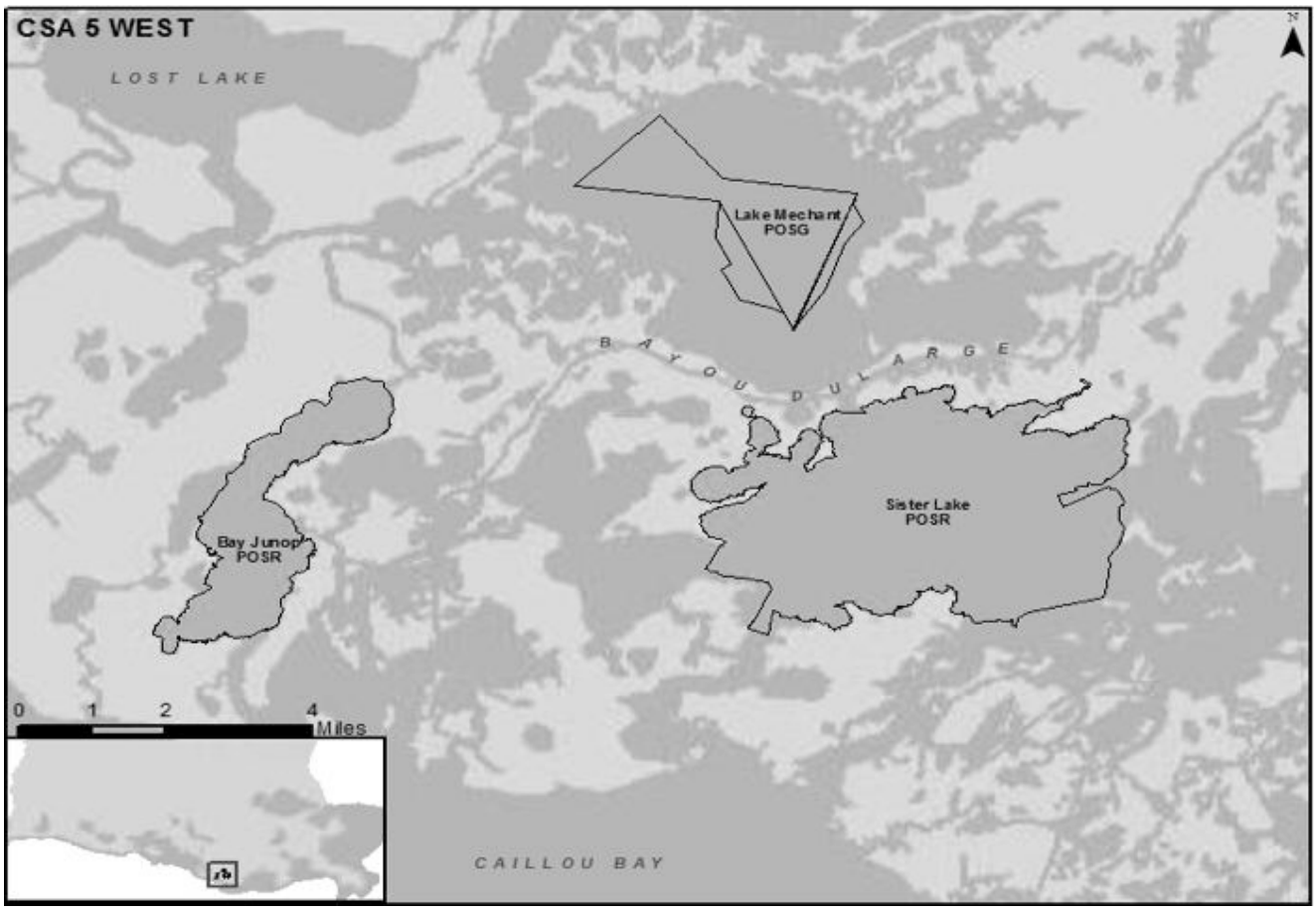

FIGURE 5.1. Public oyster areas within the western portion of Coastal Study Area 5.

In Sister Lake, the most productive oyster area in CSA 5, estimated seed and market-size oyster availability for 2018 were 68 and 80 percent below long-term averages (1980-2017), respectively. The 2018 oyster stock assessment estimated 46,493 bbls of seed and 21,789 bbls of market-size oysters on the Sister Lake Public Oyster Seed Reservation, of which 45 percent (20,914 bbls) of available seed and 4 percent (820 bbls) of available market-size oysters were located on the 2012 cultch plant (*Figure 5.6*). When examining the Grand Pass Reef Complex data, most of the market-size oysters come from one location. The North 1994 Shell Plant accounts for 91 percent of this total. Of the five replicates for this location, two replicates contained all of the oysters (43) in two clusters. For context, the 2018 estimated oyster availability for the North 1994 Shell Plant was 96 percent higher than its five-year average. Although the Grand Pass Reef Complex showed some stock available for industry use, these numbers likely do not represent actual oyster availability. Stock availability is likely inflated due to the previously mentioned North 1994 Shell Plant replicates.

During the 40-day 2017/2018 season, the market-size oyster stock availability in the Grand Pass Reef Complex (Sampling Station 3020) was severely depleted. There was likely illegal harvest pressure after the fall season was closed as illegal harvest from the Sister Lake Public Oyster Seed Reservation has become an issue. LDWF enforcement agents have made multiple cases in this area on a near monthly basis. These cases are potentially a fraction of the illegal harvesting activity taking place. This alleged undocumented harvest, conveyed by local commercial fishermen to field biologists, is a likely contributor to the overall decline in available stock.

Lake Mechant and the northern portion of Bay Junop, near Buckskin Bayou (Sampling Station 3038), receive input from the Atchafalaya River via Blue Hammock Bayou on an annual basis. This continues to have a large influence on salinity levels, which inhibits and affects oyster growth and productivity in this area.

In Lakes Chien and Felicity in the eastern Terrebonne Basin, availability of seed oysters was 93 percent below the longterm average; availability of market-size oysters was 100 percent below the long-term average. Both cultch plants in Lake Chien showed a marked decrease in seed oyster availability, and there were no market-size oysters in the 2018 square-meter samples (*Figures 5.9 and 5.10*).

Continued marsh degradation in the eastern Terrebonne Basin allowed salinities to fluctuate widely based on prevailing wind direction, and the constant erosion added sediment to the system, which can increase reef burial. The majority of the Lake Felicity cultch plant was covered with sediment and has shown zero productivity of market-size oysters in the last five years. However, the area contained an estimated 495 bbls of seed stock in 2017, the highest estimate for this cultch plant since 2012, yet no oysters were collected in any of the 2018 samples.

Spat Production

Average number of oyster spat ranged from 0 to 16 per sampling station in 2018 (*Table 5.5*). Lake Mechant had the highest number per sample, with an average of 16. In the western Terrebonne Basin, all samples showed a decrease in the number of spat present; in

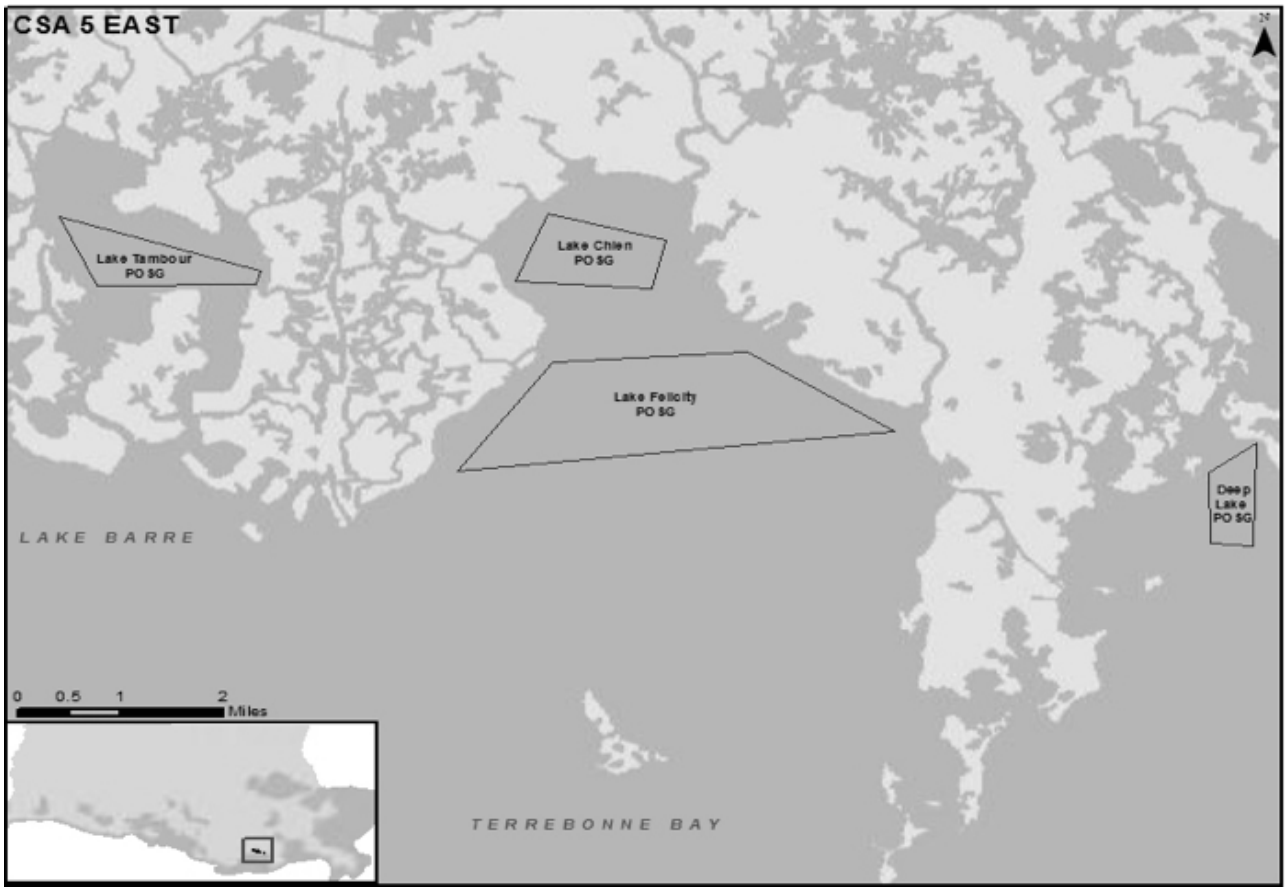

FIGURE 5.2. Public oyster areas within the eastern portion of Coastal Study Area 5.

the eastern Terrebonne Basin, Lake Mechant was the exception, showing a slight increase.

Significant reductions in the eastern Terrebonne Basin were recorded, with an average spat collection of less than one per m^2 in Lake Chien and no recovered spat in Lake Felicity, a 99.2 and 100.0 percent reduction from the previous year, respectively.

Hydrological Data

Average water temperatures for May and June 2018 (the two months prior to sampling) on each public oyster area in CSA 5 ranged from 28.7 to 29.3°C, slightly above the long-term average (1996-2017). Average salinities for May and June 2018 were below the long-term averages for all areas (*Tables 5.6 and 5.7*). Biologists collected these data during dredge samples. Temperature and salinity measurements collected concurrently with square-meter sampling in July averaged 29.9°C and 14.2 ppt, respectively, in the eastern Terrebonne Basin, 29.3°C and 8.4 ppt in Sister Lake, 28.1°C and 6.7 ppt in Bay Junop, and 28.1°C and 0.5 ppt in Lake Mechant.

Mortality

Biologists observed one dead seed and two dead spat oysters in the 2018 square-meter samples for western Terrebonne Basin (*Table 5.8*). The dead seed oyster was collected from Grand Pass (Sampling Station 200), and the dead spat were collected from the North 1994 Shell Plant (Sampling Station 213). No mortality was recorded for the eastern Terrebonne Basin.

Fouling Organisms, Predators, and Disease

Biologists collected three types of incidental species (hooked mussel, mud crab, and oyster drill) during 2018 square-meter sampling (*Table 5.9*). Hooked mussels were the most abundant incidental species and were more prevalent in western Terrebonne Basin samples, with an overall average of 17.4 hooked mussels per sample. Of this overall average, Sister Lake had the highest occurrence with 24.8 hooked mussels per sample; eastern Terrebonne Basin samples showed an average of 0.2 hooked mussels per sample.

Scientific literature suggests that Dermo may cause extensive oyster mortalities in conditions of high salinities and water temperatures. Results of Dermo tests are presented in Appendix I.

Tropical and Climatic Events

No significant tropical or climatic activity affected CSA 5 for the period covered by this report.

2017/2018 Oyster Season

The Commission opened Sister Lake on Nov. 13, 2017, and closed the area Dec. 22, 2017. Seed harvest was only open for one day; during that time, an estimated 6,410 bbls of seed oysters were harvested (*Tables 5.10 and 5.11*). A daily take and possession limit of 35 sacks was imposed at the beginning of the season but was reduced to 25 sacks on Nov. 28, 2017, for the remainder of the

season. An estimated 1,178 vessel days yielded 25,290 sacks of market-size oyster harvested during this season (*Tables 5.10 and 5.11*).

The Commission did not open Lake Mechant, Bay Junop, Lake Chien or Lake Felicity during the 2017/2018 season.

TABLE 5.1. 2018 Sister Lake oyster availability by sampling station (bbls = barrels).

Station Number (New/Old)	Reef Acreage	Number m²	Average Number Seed Oysters/m²	Average Number Market-Size Oysters/m²	Bbls Seed Oysters	Bbls Market-Size Oysters	Oyster Spat/m²
3020/200*	320	1,296,253	1.5	0.5	2,700.5	1,800.4	3,600.7
3028/203	140	568,302	0.0	0.0	0.0	0.0	0.0
3015/207	56	225,694	0.0	0.0	0.0	0.0	0.0
3021/213	191	773,114	10.6	8.6	11,382.0	18,468.8	36,937.7
3022/214	552	2,235,653	1.0	0.0	3,105.1	0.0	0.0
3023/215	513	2,075,194	0.0	0.0	0.0	0.0	0.0
3026/218	82	332,896	0.0	0.0	0.0	0.0	0.0
3042/219	156	629,369	9.6	0.4	8,391.6	699.3	1,398.6
2012 Cultch Plant	365	1,476,298	10.2	0.2	20,914.2	820.2	1,640.3
Total	***2,375***	***9,612,773***	***32.9***	***9.7***	***46,493.4***	***21,788.7***	***43,577.3***

*Average of stations 3020/200, 3010/202, and 3024/216 to represent the Grand Pass Reef Complex.

TABLE 5.2. 2018 Bay Junop/Lake Mechant oyster availability by sampling station (bbls = barrels).

Station Number (New/Old)	Reef Acreage	Number m²	Average Number Seed Oysters/m²	Average Number Market-Size Oysters/m²	Bbls Seed Oysters	Bbls Market-Size Oysters	Oyster Spat/ m²
3038/251	17	69,606	0.6	1.0	58.0	193.4	386.7
3035/252*	67	272,598	0.2	0.0	75.7	0.0	0.0
3036/253	73	296,474	0.6	0.2	247.1	164.7	329.4
3029/300	30	121,406	8.8	0.0	1,483.9	0.0	0.0
Total	***187***	***760,083***	***10.2***	***1.2***	***1,864.6***	***358.1***	***716.1***

*Average of stations 3035/252 and 3037/255 to represent the South Bay Junop Reef Complex.

TABLE 5.3. 2018 Lake Chien/Lake Felicity oyster availability by sampling station (bbls = barrels).

Station Number (New/Old)	Reef Acreage	Number m²	Average Number Seed Oysters/m²	Average Number Market-Size Oysters/m²	Bbls Seed Oysters	Bbls Market-Size Oysters	Oyster Spat/ m²
3040/2	16	64,750	2.8	0.0	251.8	0.0	0.0
3039/1	40	161,875	0.0	0.0	0.0	0.0	0.0
3041/3	22	90,245	1.6	0.0	200.5	0.0	0.0
Total	***78***	***316,870***	***4.4***	***0.0***	***452.4***	***0.0***	***0.0***

TABLE 5.4. Oyster availability and percent change from the 2017 to 2018 assessment for both regions of Coastal Study Area 5 (bbls = barrels).

Region	Area	Bbls of Seed Oysters			Bbls of Market-Size Oysters		
		2017	2018	% Change	2017	2018	% Change
Western Terrebonne Basin	Sister Lake	70,719.3	46,493.4	-34.3	14,761.7	21,788.7	47.6
	Bay Junop	590.2	380.8	-35.5	847.5	358.1	-57.8
	Lake Mechant	1,618.8	1,483.9	-8.3	0.0	0.0	0.0
Eastern Terrebonne Basin	Lake Chien	197.8	452.4	228.7	0.0	0.0	0.0
	Lake Felicity	494.6	0.0	-100.0	0.0	0.0	0.0

TABLE 5.5. Average oyster spat per square-meter sample for the 2017 and 2018 assessments for all areas in Coastal Study Area 5.

Region	Area	Oyster Spat/m²	
		2017	2018
Western Terrebonne Basin	Sister Lake	5.5	0.4
	2012 Cultch Plant	8.8	1.6
	Bay Junop	5.3	0.1
	Lake Mechant	14.4	16.0
Eastern Terrebonne Basin	Lake Chien	51.7	0.4
	Lake Felicity	119.2	0.0

TABLE 5.6. Average May-June 2018 and historical average (excluding 2018) water temperatures (°C) and salinities (parts per thousand) from Sister Lake, Bay Junop, and Lake Mechant dredge samples (X = not designated as seed ground or reservation, thus no data were collected).

Year	Temperature			Salinity		
	Sister Lake	Bay Junop	Lake Mechant	Sister Lake	Bay Junop	Lake Mechant
1996	29.4	29.3	X	17.2	18.2	X
1997	29.0	28.8	X	7.7	10.1	X
1998	29.0	28.8	X	10.5	8.6	X
1999	28.2	27.5	X	14.1	13.4	X
2000	29.6	29.2	X	24.9	23.8	X
2001	27.5	27.5	X	12.1	14.0	X
2002	28.4	27.9	X	11.0	11.4	X
2003	29.1	28.9	X	7.5	9.2	X
2004	29.4	28.7	X	14.1	17.2	X
2005	28.3	27.9	X	16.1	19.0	X
2006	28.1	26.1	X	22.7	20.4	X
2007	27.6	27.5	27.8	19.3	20.0	11.5
2008	26.7	28.1	28.1	6.2	6.9	0.4
2009	29.5	29.1	28.6	10.3	12.0	2.6
2010	29.8	28.3	28.9	17.8	15.4	15.1
2011	26.4	26.5	25.7	16.1	16.1	5.5
2012	29.3	29.3	29.0	16.5	17.7	9.4
2013	28.1	27.8	27.8	9.3	11.0	1.9
2014	28.1	27.7	27.5	15.4	16.3	6.5
2015	27.8	28.0	27.6	7.6	7.7	0.9
2016	28.3	28.2	27.9	11.7	13.0	3.5
2017	27.4	27.3	27.4	8.3	9.6	1.5
2018	29.3	29.1	28.7	9.7	10.7	1.8
Average	***28.4***	***28.1***	***27.8***	***13.5***	***14.1***	***5.3***

TABLE 5.7. Average May-June 2018 and historical average (excluding 2018) water temperatures (°C) and salinities (parts per thousand) from Lake Felicity and Lake Chien dredge samples.

Year	Temperature		Salinity	
	Lake Felicity	Lake Chien	Lake Felicity	Lake Chien
2006	27.6	27.8	24.9	25.0
2007	27.4	27.6	20.9	20.7
2008	28.2	28.6	16.0	16.0
2009	28.3	28.6	21.3	21.1
2010	29.2	29.5	18.6	17.8
2011	27.2	27.5	25.0	24.9
2012	29.0	29.0	20.0	19.2
2013	25.2	25.3	15.0	13.6
2014	26.2	26.5	19.8	18.3
2015	27.3	27.6	14.9	14.1
2016	27.0	27.3	15.2	13.8
2017	26.5	26.8	16.1	15.4
2018	28.8	29.0	17.0	16.5
Average	***27.4***	***27.7***	***19.0***	***18.3***

TABLE 5.8. Overall percent mortality of spat, seed, and market-size oysters for all areas in Coastal Study Area 5 in 2018.

Region	Area	Spat	Seed	Market-Size
Western Terrebonne Basin	Sister Lake	7.1	0.6	0.0
	Bay Junop	0.0	0.0	0.0
	Lake Mechant	0.0	0.0	0.0
Eastern Terrebonne Basin	Lake Felicity	0.0	0.0	0.0
	Lake Chien	0.0	0.0	0.0

TABLE 5.9. Average numbers of hooked mussels, oyster drills, and select crab species per sample by seed ground or reservation and overall in Coastal Study Area 5 in 2018.

Region	Seed Ground	Average Numbers per Sample				
		Hooked Mussels	Mud Crab	Oyster Drill	Stone Crab	Green Porcelain Crab
Western Terrebonne Basin	Sister Lake	24.8	0.8	0.0	0.0	0.0
	Bay Junop	0.5	0.3	0.0	0.0	0.0
	Lake Mechant	4.6	0.2	0.0	0.0	0.0
	Overall	***17.4***	***0.7***	***0.0***	***0.0***	***0.0***
Eastern Terrebonne Basin	Lake Felicity	0.0	0.0	0.0	0.0	0.0
	Lake Chien	0.3	0.1	0.0	0.0	0.0
	Overall	***0.2***	***0.1***	***0.0***	***0.0***	***0.0***

TABLE 5.10. Annual totals and long-term averages of commercial seed (barrels) and market-size (sacks) oyster harvests from Lake Felicity and Lake Chien cultch plants (NS = no season).

Year	Lake Felicity		Lake Chien	
	Seed	Market-Size	Seed	Market-Size
2005	15	0	253	0
2006	0	0	1,940	0
2007	470	4,830	2,157	2,439
2008	0	0	205	17
2009	NS	NS	NS	NS
2010	0	205	0	405
2011	671	351	156	2,458
2012	0	37	0	1022
2013	NS	NS	NS	NS
2014	NS	NS	NS	NS
2015	0	0	0	870
2016	NS	NS	NS	NS
2017	NS	NS	NS	NS
Average	***145***	***678***	***589***	***901***

TABLE 5.11. Annual totals and long-term averages of commercial seed (barrels) and market-size (sacks) oyster harvests from Sister Lake, Lake Mechant, and Bay Junop (NS = no season; X = not designated as seed ground or reservation).

Year	Sister Lake		Bay Junop		Lake Mechant	
	Seed	Market-Size	Seed	Market-Size	Seed	Market-Size
1995	51,160	48,824	NS	NS	X	X
1996	20,055	40,019	3,770	26,908	X	X
1997	31,668	43,727	NS	NS	X	X
1998	15,228	16,510	6,205	20,345	X	X
1999	29,934	47,586	NS	NS	X	X
2000	NS	NS	NS	NS	X	X
2001	18,183	34,060	NS	NS	X	X
2002	NS	NS	40	1,031	X	X
2003	11,840	92,580	NS	NS	X	X
2004	NS	NS	5	2,623	0	2,211
2005	3,200	81,788	NS	NS	NS	NS
2006	NS	NS	10	3,890	NS	NS
2007	16,960	42,514	NS	NS	19,665	13,703
2008	600	5,530	0	737	NS	NS
2009	4,610	13,676	NS	NS	NS	NS
2010	NS	NS	0	433	0	91
2011	15,765	86,812	0	100	0	0
2012	NS	NS	0	1,163	1,075	2,243
2013	7,315	86,804	NS	NS	3,390	706
2014	NS	NS	0	2,347	1,175	1,490
2015	38,308	48,522	NS	NS	0	0
2016	NS	16,625	0	2,240	2,670	0
2017	6,410	25,290	NS	NS	NS	NS
Average	***18,082***	***48,725***	***836***	***5,151***	***3,108***	***2,272***

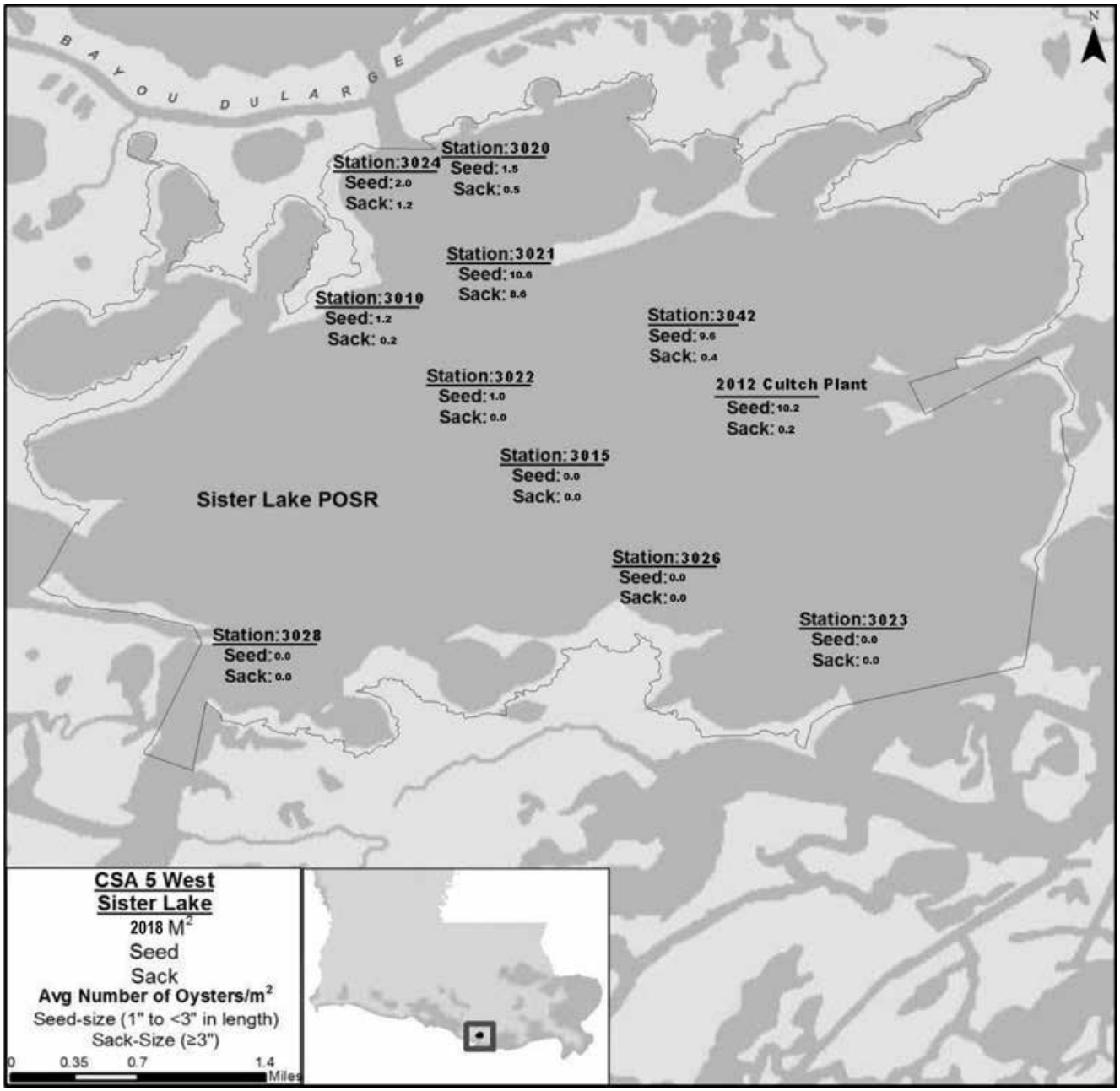

FIGURE 5.3. Results from square-meter sampling stations in Sister Lake in 2018.

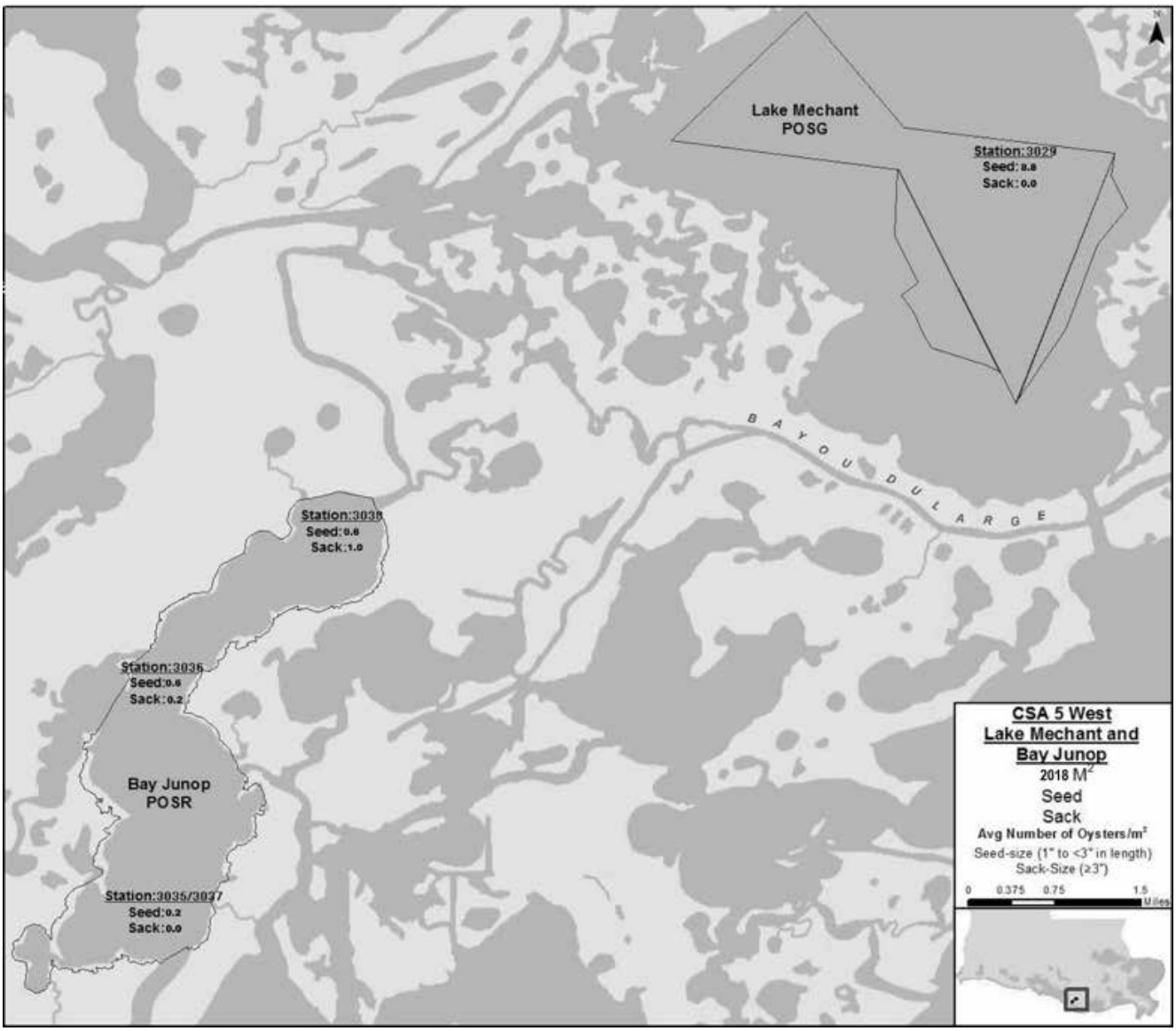

FIGURE 5.4. Results from square-meter sampling stations in Bay Junop and Lake Mechant in 2018.

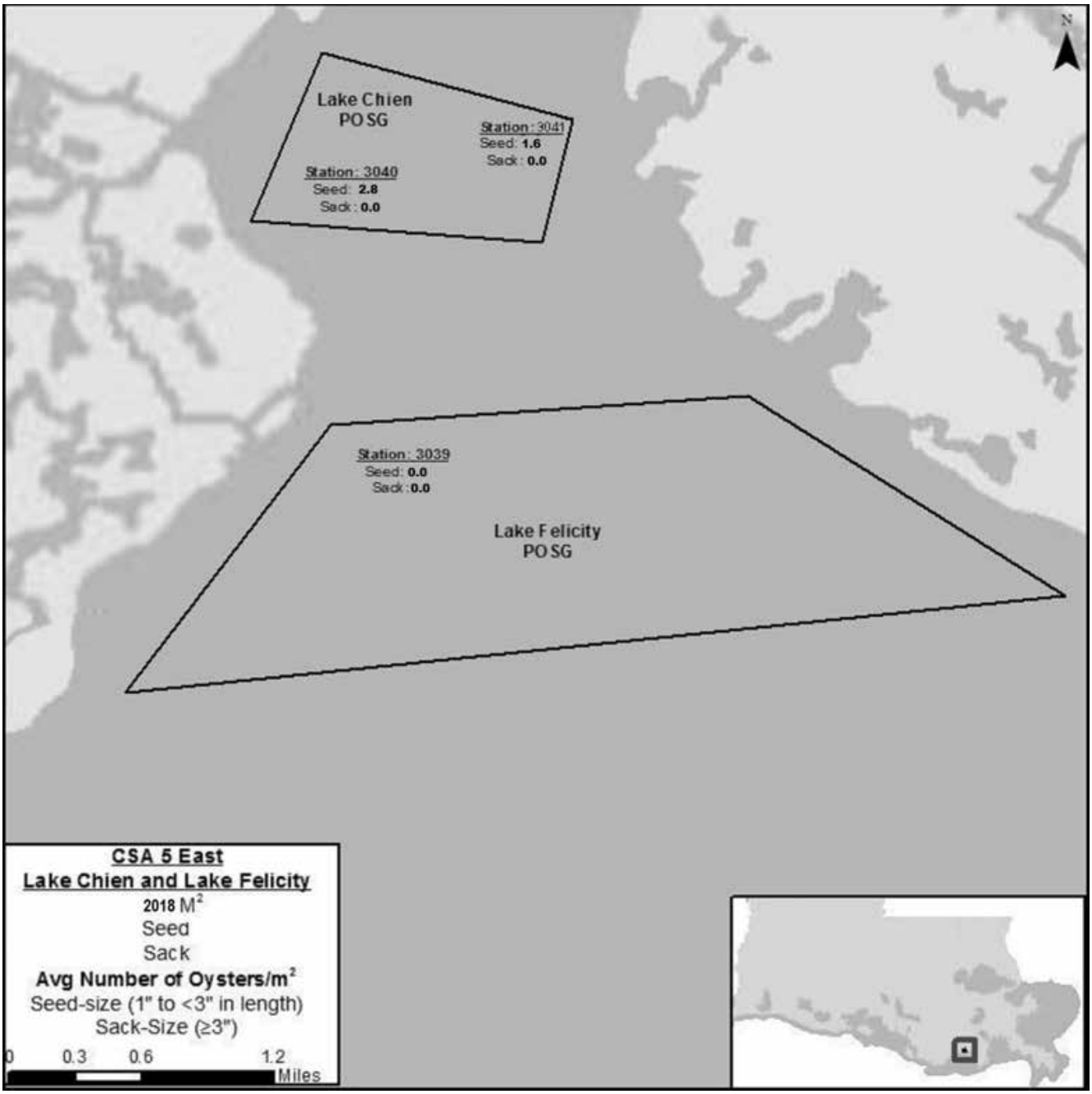

FIGURE 5.5. Results from square-meter sampling stations in Lake Chien and Lake Felicity in 2018.

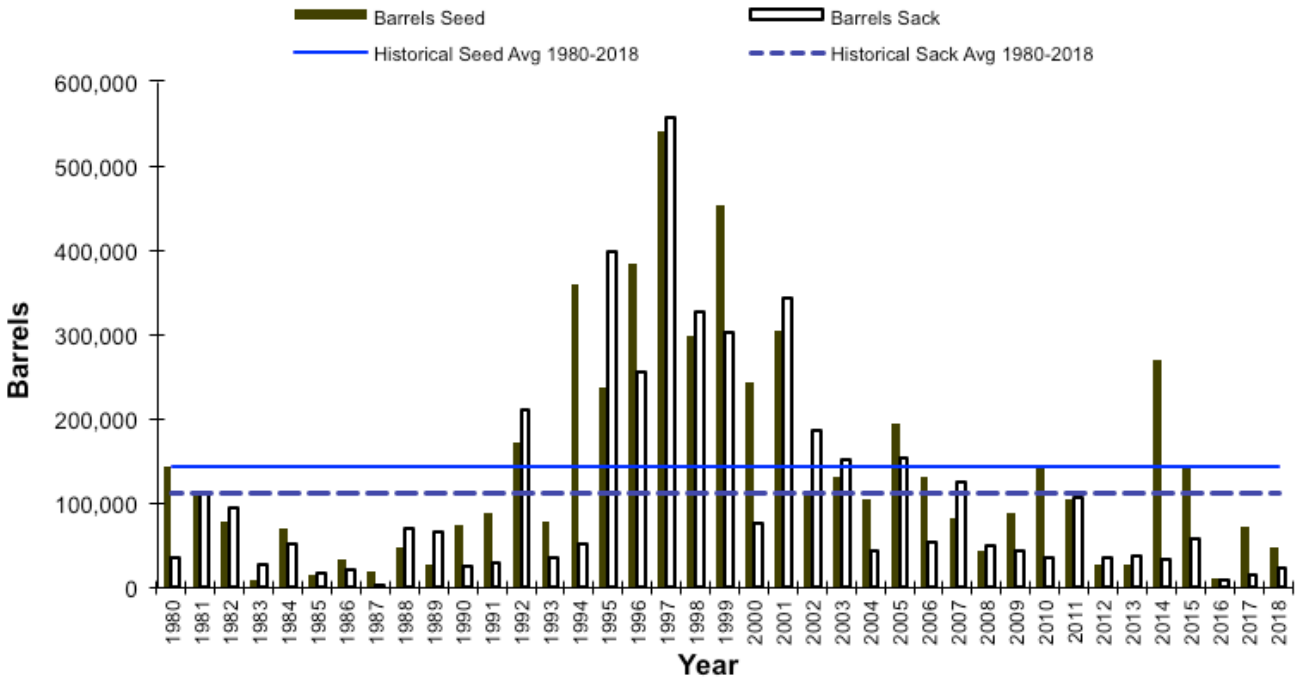

FIGURE 5.6. Sister Lake historical oyster stock availability.

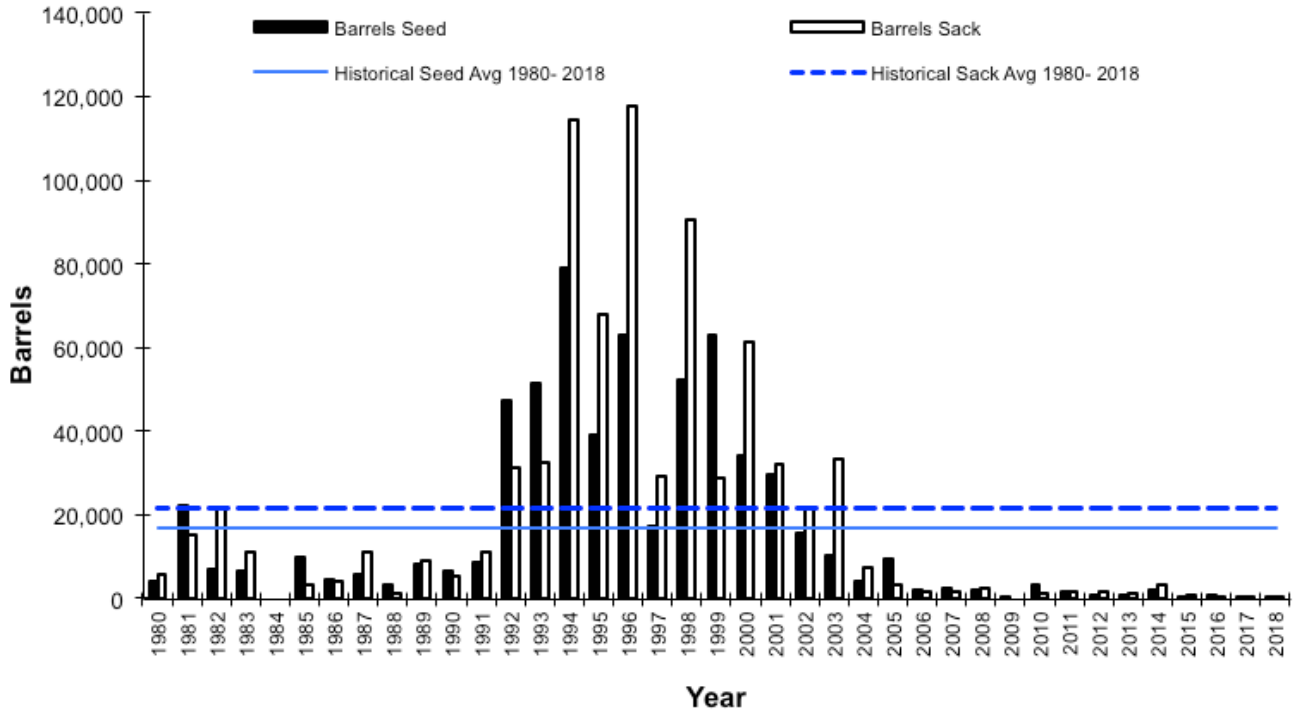

FIGURE 5.7. Bay Junop historical oyster stock availability.

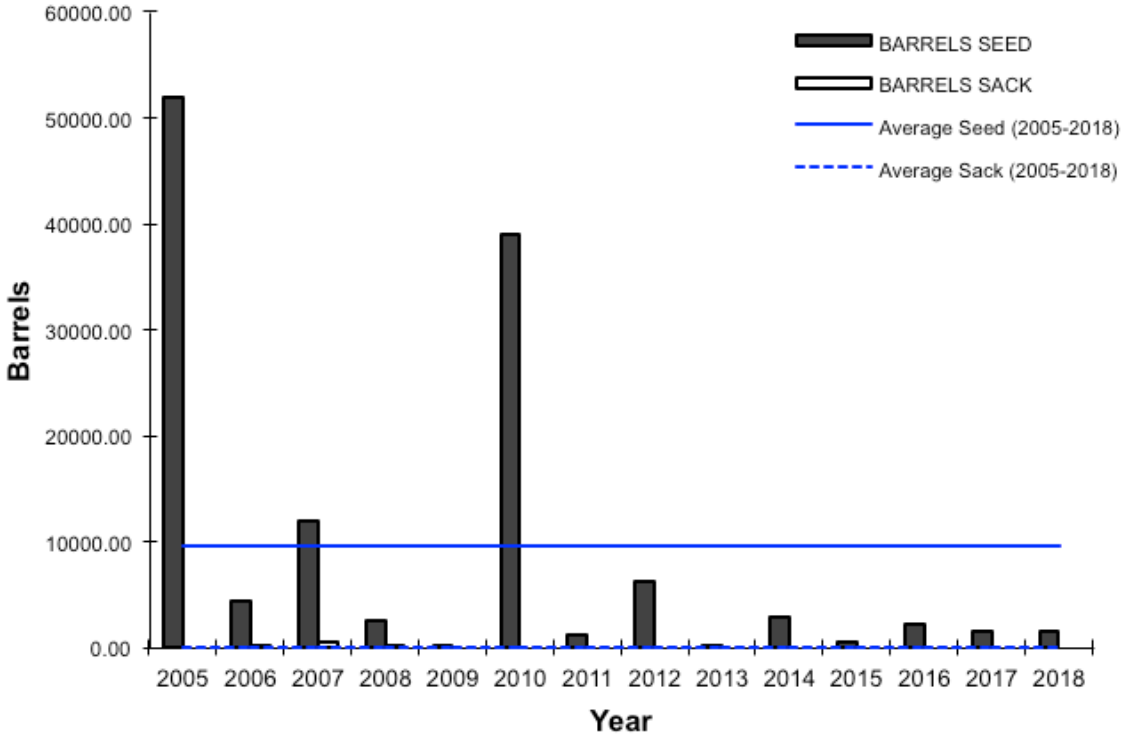

FIGURE 5.8. Lake Mechant historical oyster stock availability.

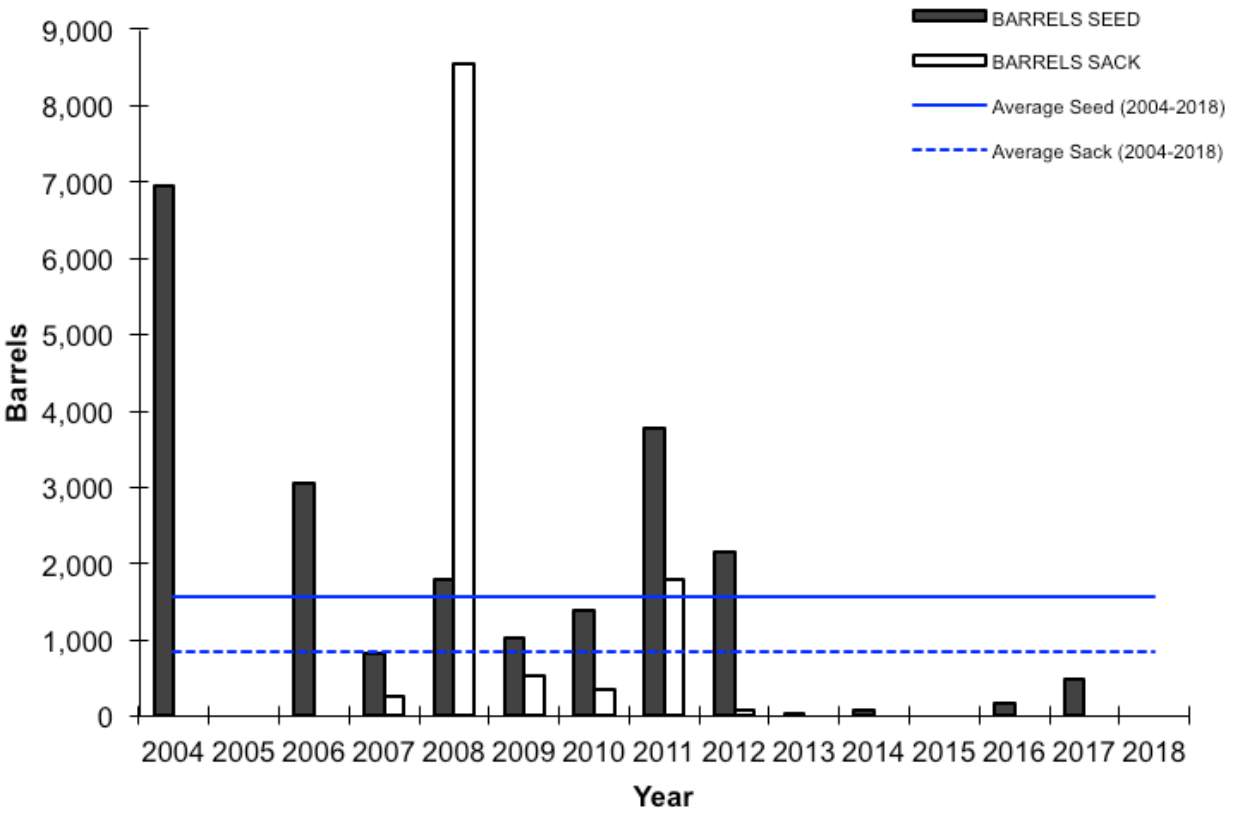

FIGURE 5.9. Lake Felicity historical oyster stock availability.

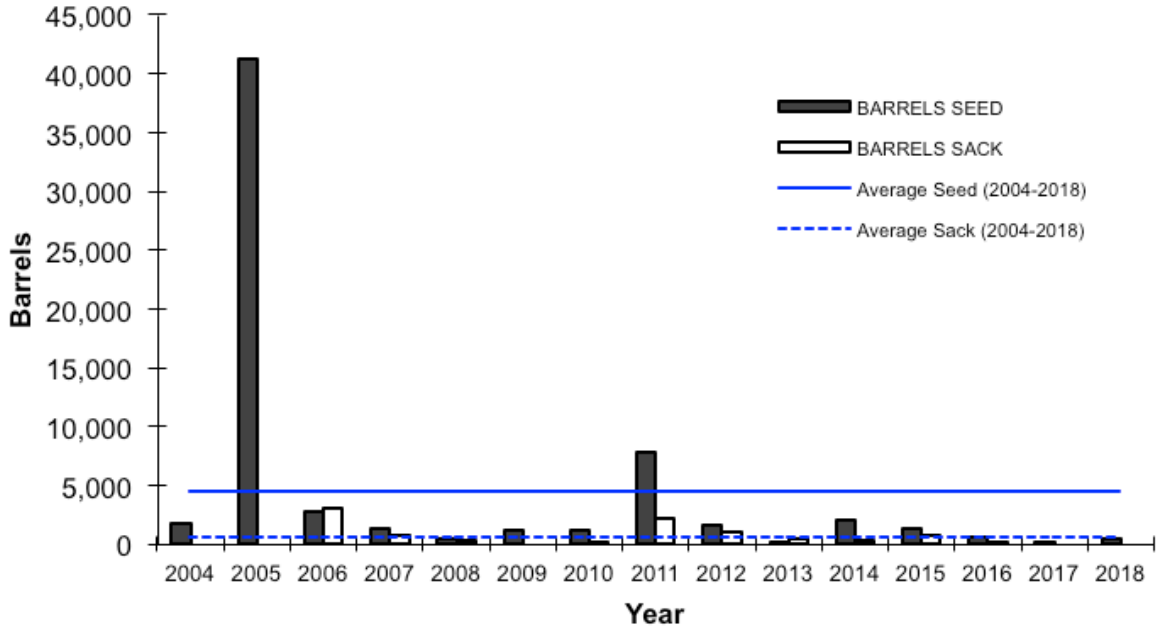

FIGURE 5.10. Lake Chien historical oyster stock availability.

CSA 6

Introduction

CSA 6 includes oyster reefs found in the Vermilion/East and West Cote Blanche/Atchafalaya public oyster seed grounds. The Commission established the inside portion of these public oyster seed grounds in 1990; this area consists of state water bottoms found generally north of a line from the western shore of Vermilion Bay and Southwest Pass eastward to Point Au Fer. The Commission established the outside portion of these public oyster seed grounds in 1988; this area consists of Louisiana State Territorial Waters from the private oyster lease boundary near Mound Point/ Marsh Island eastward to Point Au Fer. Since 1986 (prior to the official designation of these areas as public oyster seed grounds), LDWF managed the oyster resources found on local state water bottoms in a manner similar to current management procedures for public oyster seed grounds. Management allowed limited harvest/relays from the Vermilion Bay area reefs when oyster abundance and distribution permitted.

The Vermilion/East and West Cote Blanche/Atchafalaya Bay complex is a large, primarily open-water brackish system; the public oyster seed grounds in this area consist of approximately 541,787 acres of water bottom. Primary influences on the bays' dynamic salinity regime are the Gulf of Mexico, Atchafalaya River and the adjacent Wax Lake Outlet, and the Vermilion River. In general, freshwater discharge from the Atchafalaya River highly influences the public oyster seed grounds within CSA 6. Typically, oyster reproduction occurs in the fall after the river stage abates, with oysters growing to seed size (1 inch to less than 3 inches) by the following spring. However, spring and early summer floodwaters depress salinities, placing extreme physiological stress on the organisms. These low salinities, coupled with high water temperatures through the summer months, typically result in extensive oyster mortalities on the public grounds. Occasionally, however, reduced freshwater inflow from the Atchafalaya River leads to higher-than-normal salinities, and the normal annual cycle of extensive oyster mortalities is broken, leading to a harvestable population of seed oysters during the following oyster season (September through April). Such was the case in 2000, 2001, 2005, 2006, 2007, 2013, 2014, and 2017 when sizable quantities of seed oysters were available for harvest.

An overall oyster stock assessment for CSA 6 is not possible at this time, as figures relative to oyster reef sizes are not available. This report compares data collected from the 2018 oyster stock assessment sampling to previous years' sampling data, with a look at hydrological conditions, marine fouling, and oyster predators on sampled reefs. In addition, the report also presents information regarding the 2017/2018 oyster season on CSA 6 public oyster seed grounds.

Methods

LDWF biologists collected field samples for this report on July 9, 2018, from a total of 11 stations (*Figures 6.1 and 6.2*) within CSA 6 according to the methodology described in the Statewide Overview of this report. Sampling stations are listed in *Table 6.2*.

Results and Discussion

Seed and Market-Size Stock

Biologists found live seed oysters at only 8 of the 11 sampling stations (*Figures 6.1 and 6.2*). Densities of live seed ranged from 1.0 per replicate at Bayou Blanc to a high of 10.0 at Nickel Reef. Biologists collected market-size oysters at Lighthouse Point and Nickel Reef only, with densities of 0.2 and 0.4 oysters per replicate, respectively. There was a 215.8 percent increase in the number of (seed+market) oysters in 2018 samples compared to 2017.

Low production years associated with extended periods of high Atchafalaya River output are not uncommon on the seed grounds of this bay system. In the first half of 2018, Atchafalaya River levels were low during warm weather months. The favorable conditions have allowed the highest seed density within the Vermilion Bay system to occur in the last 10 years (*Figure 6.3*).

Spat Production

Despite the presence of suitable substrate at all locations, biologists found live spat at only 8 of the 11 sampling stations (*Figures 6.1 and 6.2*). Densities of spat ranged from 0.2 at Big Charles, Indian Point, and Middle reefs to a high of 2.6 per replicate at Nickel Reef. Low spat productivity during periods of high Atchafalaya River flow (with associated low salinity conditions) are common in this bay system. However, due to favorable conditions in early 2018, spat were observed at all sampling stations, except Vermilion Bay, Sally Shoal, and Rabbit Island.

Fouling Organisms

Biologists documented an overall 507.1 percent increase in hooked mussel abundance at the sampling stations compared to the 2017 oyster stock assessment. They noted an increase in density at eight stations while two stations had zero density and a third was unchanged (*Table 6.2*). The two most affected stations were High Spot and Bayou Blanc with densities of 25.8 and 68.8 hooked mussels per replicate, respectively.

Oyster Predators

Biologists did not find any southern oyster drills during square-meter sampling. These marine snails are more often associated with high salinity waters where they are known to prey heavily on

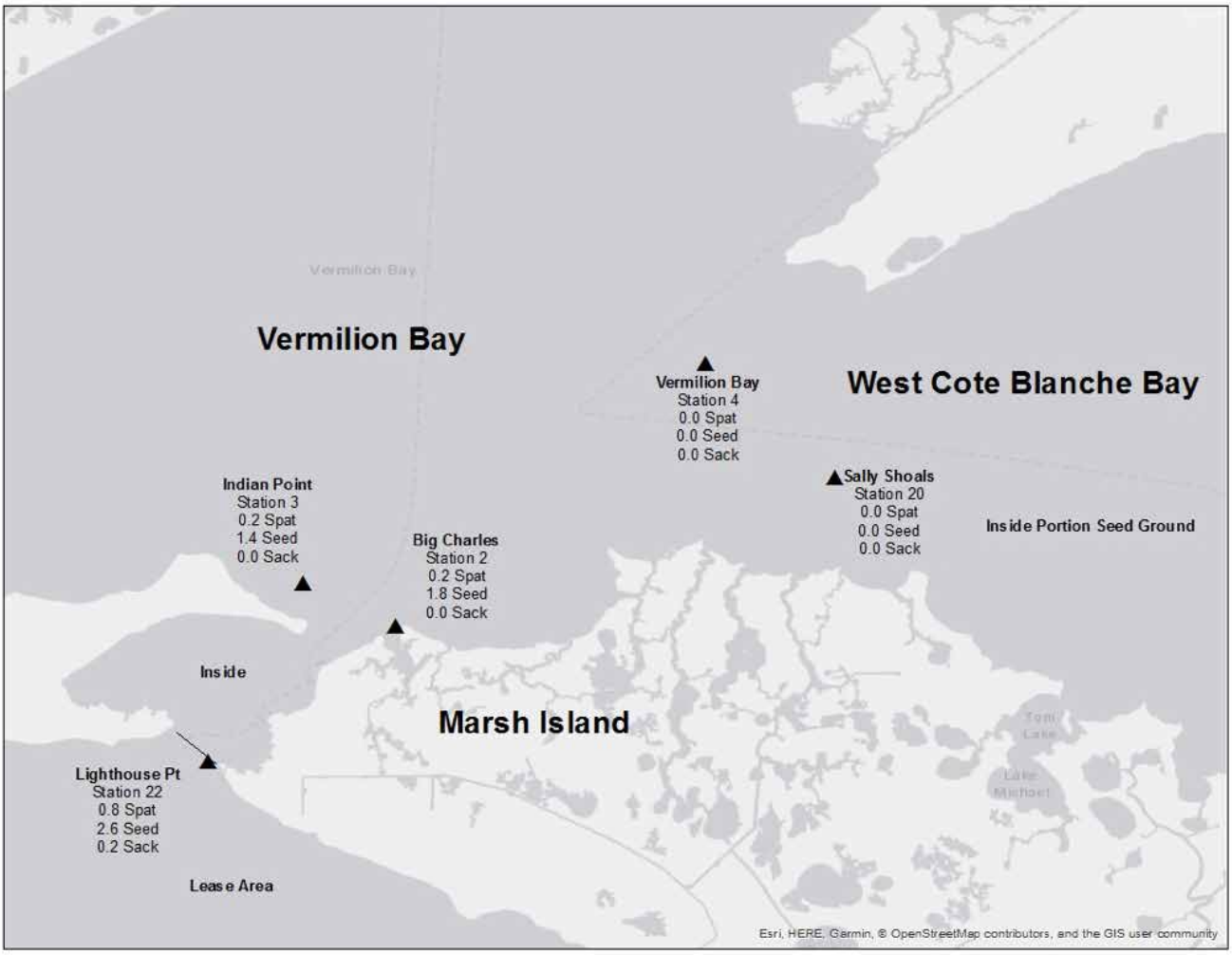

FIGURE 6.1. 2018 Coastal Study Area 6 oyster square-meter sampling stations in the western part of the Vermilion/East and West Cote Blanche/Atchafalaya Bays public oyster seed grounds. Data displayed below station numbers represent average spat, seed, and market-size oysters per square-meter sample.

oysters and other bivalve species. The occurrence of mud crab on historically sampled reefs increased 53.7 percent compared to the 2017 oyster stock assessment. Five of the 11 sampled reefs had no mud crabs, but mud crab density reached a high of 5.6 crabs per replicate at High Spot. Biologists collected one blue crab and five stone crabs during 2018 square-meter sampling.

Mortality

In the first half of 2018, there were significant numbers of seed and market-size oysters at Nickel, Middle, Lighthouse Point, High Spot and Big Charles reefs, as observed in monthly dredge samples collected throughout the year. As opposed to 2017 when the Atchafalaya River levels were high in June, river levels in 2018 were above average during March and April, typically cooler months. Dredge samples taken in April showed that salinities were below 3.2 ppt at all sampling stations except for Nickel Reef. Nickel Reef experienced 17.0 percent mortality during March, most likely due to lower salinities, and 26.3 percent mortality during late June, most likely due to higher water temperatures.

Bottom salinity levels measured during July 2018 square-meter sampling varied from 0.2 ppt at Rabbit Island to 10.3 ppt at Lighthouse Point. Bottom dissolved oxygen (DO) was in the normal range at all stations (*Table 6.3*).

Tropical and Climatic Events

Hurricane Harvey made initial landfall near Rockport, Texas, on Aug. 26, 2017. After moving back out into the Gulf of Mexico, Harvey made a second landfall near Cameron, Louisiana, at 8 am on Aug. 30, 2017. Sustained winds were at 40 knots and mostly caused a storm surge in the Vermilion Bay system of 2 to 4 feet, resulting in minor flooding of low lying areas. Most of the rain in Louisiana associated with this storm was located in Western and Central Louisiana.

Hurricane Nate made landfall at the mouth of the Mississippi River at 12 am on Oct. 8, 2017, with sustained winds of 75 knots. Most of the impacts were on the eastern side of the storm so no impacts were observed in CSA 6.

2017/2018 Oyster Season

The Commission opened the Vermilion/East and West Cote Blanche/Atchafalaya Bay public oyster seed grounds for both seeding and market-size oysters at one-half hour before sunrise on Nov. 13, 2017, and closed the area on March 12, 2018. The public oyster seed grounds remained open to sacking market-size oysters only, with a daily take and possession limit of 50 sacks of oysters per vessel. The Commission closed the season at one-half hour after

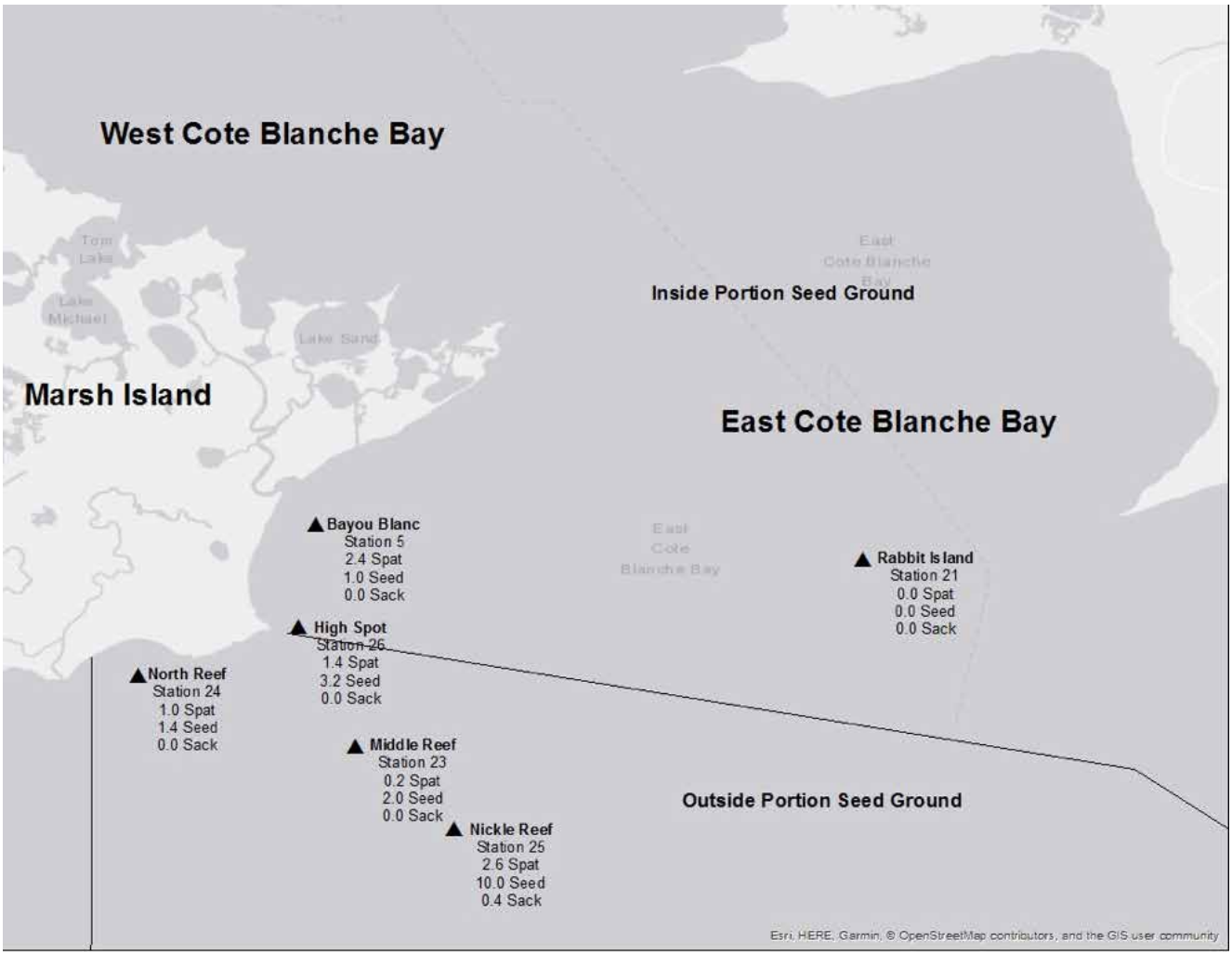

FIGURE 6.2. 2018 Coastal Study Area 6 oyster square-meter sampling stations in the eastern part of the Vermilion/East and West Cote Blanche/Atchafalaya Bays public oyster seed grounds. Data displayed below station numbers represent average spat, seed, and market-size oysters per square-meter sample.

sunset on April 30, 2018. Once the Nickel Reef area was designated "OPEN" by LDH, there was a small harvest in that area. During the first week, there were 10 boats observed. Six of the vessels were bedding and averaged 210.4 bbls per boat per day. Four vessels were observed sacking oysters and averaged 40.5 sacks per boat per day. During the second week, eight vessels were observed on the seed grounds. Six vessels were bedding and averaged 141.7 bbls per boat per day. Two were observed sacking and averaged 22.5 sacks per boat per day. Sacking effort declined significantly after the first couple of days due to the lack of market-size stock available on the seed grounds of CSA 6. When the seed grounds were closed to bedding on March 12, 2018, effort dropped to zero on the Vermilion/East and West Cote Blanche/Atchafalaya Bay public oyster seed grounds.

TABLE 6.1. Mean density of live seed and market-size oysters collected in Coastal Study Area 6 square-meter samples by year.

Year	Mean Density Seed/Sample	Mean Density Market-Size/Sample	Seed/Market-Size Ratio
2000	81.4	3.3	27.1:1
2001	28.8	4.8	6.0:1
2002	2.3	0.3	9.0:1
2003	1.2	0.0	No market-size oysters
2004	4.3	0.0	No market-size oysters
2005	14.8	0.0	No market-size oysters
2006	16.1	0.5	32.2:1
2007	11.6	0.8	14.5:1
2008	1.3	0.0	No market-size oysters
2009	3.4	0.0	No market-size oysters
2010	0.8	0.1	6.7:1
2011	0.3	0.0	16.0:1
2012	1.8	0.0	44.5:1
2013	0.3	0.0	15.0:1
2014	1.1	0.1	14.0:1
2015	0.4	0.0	No market-size oysters
2016	1.2	0.2	7.5:1
2017	0.6	0.1	5.3:1
2018	2.1	0.1	42.6:1

TABLE 6.2. Mean density of hooked mussels recorded at each Coastal Study Area 6 square-meter sampling station by year.

Station Name/Number	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Big Charles/002	0.0	18.4	5.2	21.2	4.8	1.0	6.2	3.2	0.8	2.4
Indian Point/003	16.0	18.2	20.4	16.6	5.4	8.0	1.0	4.6	2.6	6.4
Vermilion Bay/004	37.0	0.0	6.6	29.8	38.2	25.2	12.6	3.0	0.2	0.0
Bayou Blanc/005	0.0	4.0	2.0	13.4	9.0	4.6	28.4	10.8	2.8	68.8
Sally Shoals/020*	-	-	3.8	25.2	4.8	12.4	5.6	8.6	0.4	5.8
Rabbit Island/021*	-	-	0.0	0.0	0.0	0.2	0.2	0.2	0.4	0.0
Lighthouse Point/022*	-	-	11.8	5.2	0.8	1.4	4.8	2.2	1.2	7.4
Middle Reef/023*	-	-	0.2	11.8	0.8	0.4	5.8	0.4	4.8	8.6
North Reef/024*	-	-	4.4	12.6	4.6	0	4.2	1.8	1.6	9.8
Nickel Reef/025**	-	-	-	-	-	-	0.6	13.0	3.0	2.2
High Spot/026***	-	-	-	-	-	-	-	4.6	5.4	25.8

*2011 was the first year of square-meter sampling at these stations.
**2015 was the first year of square-meter sampling at these stations.
***2016 was the first year of square-meter sampling at these stations.

TABLE 6.3. Dissolved oxygen (milligrams per liter) and salinity (parts per thousand) recorded with YSI Pro quatro at each Coastal Study Area 6 sampling station (measured on top and bottom layers of the water column) in 2018.

Station Name/Number	Salinity Top	Salinity Bottom	Dissolved Oxygen Top	Dissolved Oxygen Bottom
Big Charles/002	8.3	9.1	8.3	6.9
Indian Point/003	9.0	9.4	8.2	6.7
Vermilion Bay/004	4.1	4.8	9.0	8.0
Bayou Blanc/005	3.7	3.8	7.4	6.7
Sally Shoals/020	3.6	3.6	9.0	8.8
Rabbit Island/021	0.2	0.2	7.5	7.2
Lighthouse Point/022	10.3	10.3	7.8	7.5
Middle Reef/023	2.8	3.2	9.2	7.3
North Reef/024	4.7	4.7	9.9	7.9
Nickel Reef/025	2.2	2.8	10.0	8.1
High Spot/026	4.2	4.5	7.0	6.4

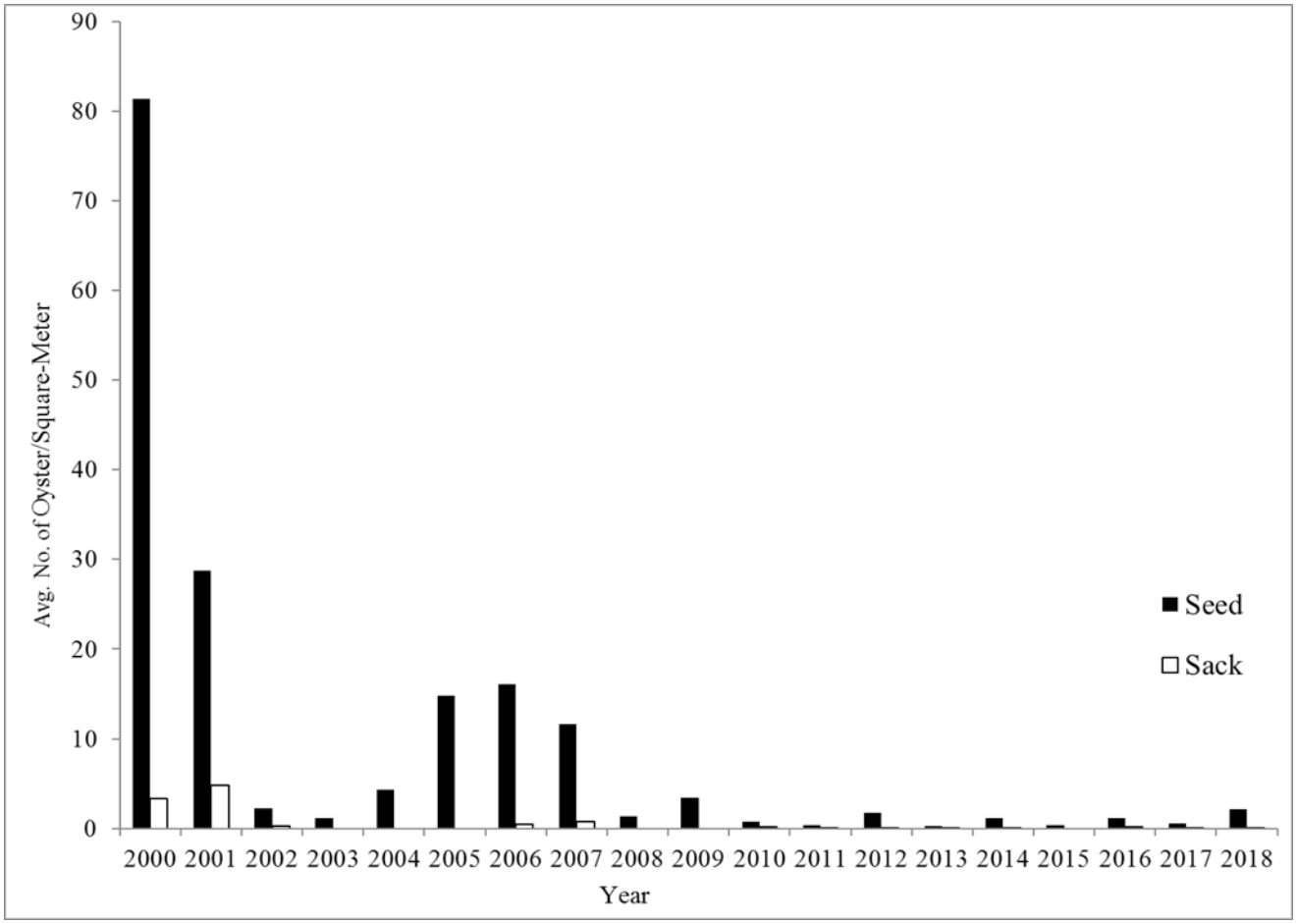

FIGURE 6.3. Mean density of live seed and sack (market-size) oysters collected in Coastal Study Area 6 square-meter samples by year.

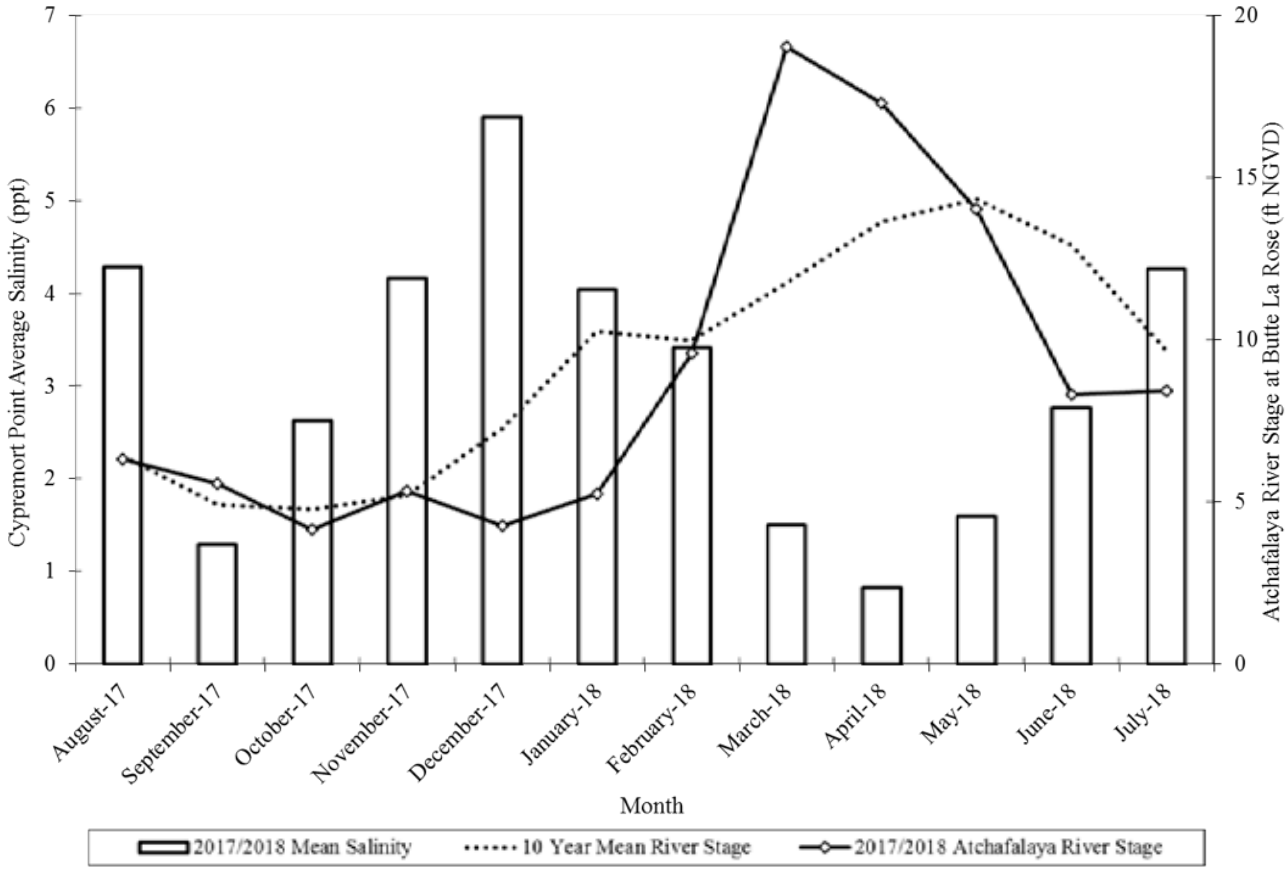

FIGURE 6.4. Atchafalaya River levels at the Butte La Rose gauge and average salinity for Cypremort Point, Louisiana, from Aug. 1, 2017 through July 31, 2018. Includes the 10-year average monthly river stage at the Butte La Rose gauge.

CSA 7

Introduction

CSA 7 is located in Southwest Louisiana, from the Louisiana/Texas state line to Freshwater Bayou in Vermilion Parish. It is comprised of Calcasieu and Mermentau River basins and the eastern portion of the Sabine River Basin. Calcasieu Lake is located at the southern end of the Calcasieu River Basin in Calcasieu and Cameron parishes; the lake consists of approximately 58,260 acres of water bottom with oyster reefs located throughout, especially in the southern end. There are no oyster harvesting areas in the Mermentau River Basin. Sabine Lake, located at the southern end of the Sabine River Basin in Cameron Parish, consists of approximately 55,057 acres of water bottom. Approximately 34,067 acres are located in the Louisiana portion of the lake; the remainder is in the Texas portion. Oyster reefs are mainly found in the very southern portion of the lake in Louisiana.

It is unclear when commercial oyster harvesting began on Calcasieu Lake and to what extent it took place. Early reports from the Gulf Biologic Station near present-day Cameron, Louisiana, documented that oyster harvest occurred south of the lake in Calcasieu Pass as early as the summer of 1903. In 1967, the Legislature closed Calcasieu Lake to oyster harvesting; the closure remained until 1975. The State reopened oyster harvesting in the lake in 1975 but implemented gear restrictions, allowing harvest only by hand or tongs. Gear restrictions remained in effect until 2004, when legislation (Act 479) allowed for the use of hand oyster dredges of 3-feet wide or less in the lake. In 2006, legislation (Act 398) allowed the use of mechanical retrieval systems for dredges. In 2011, legislation (Act 329) restricted oyster harvest in Calcasieu Lake to those who possessed a Calcasieu Lake Oyster Harvester Permit. Legislation limited the number of permits granted to 126 oyster harvesters, 63 of which had to have historical oyster landings from Calcasieu Lake, with the remaining being first come first served. In 2012, legislation (Act 541) removed the landings requirement as well as the restriction on the number of harvesters that could possess the permit. In 2017, legislation (Act 259) restricted allowable commercial oyster harvest gear in Calcasieu and Sabine lakes to hand tongs only. Mechanical scrapers are no longer a legal gear for oyster harvest in Calcasieu Lake.

Based on anecdotal information, there has been no oyster season in Sabine Lake since the early 1960s. Neither Texas nor Louisiana can document harvest since then nor locate any concrete harvest data. During the 2018 regular legislative session, Act 159 was passed, placing a permanent moratorium on the harvest of oysters in Sabine Lake. As a result, LDWF decided to conduct oyster stock assessments in this area every other year; therefore, no stock assessment was conducted for 2018.

For assessment purposes, Calcasieu Lake has always been divided into two areas - Eastside and West Cove (the Calcasieu Ship Channel being the dividing line). In 1992, LDH also divided the lake into two separately managed shellfish harvest areas - Calcasieu Lake Conditional Managed Area (CLCMA) and West Cove Conditional Managed Area (WCCMA). Classifying the areas as conditionally managed gives LDH the authority to close the areas to oyster harvest based on health-related concerns due to poor water quality. Originally, LDH established these closures in Calcasieu Lake based on the river stage of the Calcasieu River at Kinder, Louisiana. LDH would close CLCMA to oyster harvest when the river stage reached 12 feet and WCCMA when the river stage reached 7 feet. Once the river fell below these levels for 48 hours, LDH would reopen the areas for harvest. In 1998, LDH adjusted the CLCMA river stage threshold to 13.5 feet. In 2004, LDH reclassified the conditional managed areas into oyster growing areas. LDH has classified the Eastside of Calcasieu Lake as Growing Area 29 (GA-29) and the West Cove as Growing Area 30 (GA-30; *Figure 7.1*). Prior to the start of the 2013/2014 oyster season, LDH changed the Calcasieu River stage threshold for health-related closures for GA-30 (West Cove) from 7 feet to 9 feet at Kinder, Louisiana.

In March 2011, LDH also established that oysters can only be harvested in the southern portion of the Eastside (GA-29) where water quality meets minimum standards, limiting the amount of acreage available to oyster harvest. The total area available for harvest in GA-29 has been changed several times over the years; the current acreage is approximately 26,736 acres of water bottom. GA-30 has remained the same at approximately 9,248 acres of water bottom.

Prior to 2011, LDWF estimated oyster reef acreage in Calcasieu Lake to total approximately 1,690.9. West Cove contained an estimated 726.9 acres of reef; the Eastside contained approximately 963.9 acres. Since 2011, LDWF oyster stock assessments in Calcasieu and Sabine Lakes have used acreage estimates determined by side-scan sonar water bottom studies conducted in 2008 and 2011. LDWF identified all suitable oyster habitat (Bottom Type IIIB) within the LDH Public Oyster Growing Areas in Calcasieu Lake and classified this habitat into one of two bottom types: reef or scattered shell. The results of the side-scan studies estimated that GA-29 has a total of 1,962.3 acres of suitable oyster habitat, including 1,435.8 acres of reef and 526.5 acres of scattered shell bottom, and that GA-30 has a total of 3,387.8 acres of suitable oyster habitat, including 1,119.6 acres of reef and 2,268.2 acres of scattered shell bottom (*Figure 7.2*). The acreage estimates generated from the side-scan sonar studies only include those areas of Calcasieu Lake that lie within the LDH-allowed harvest areas.

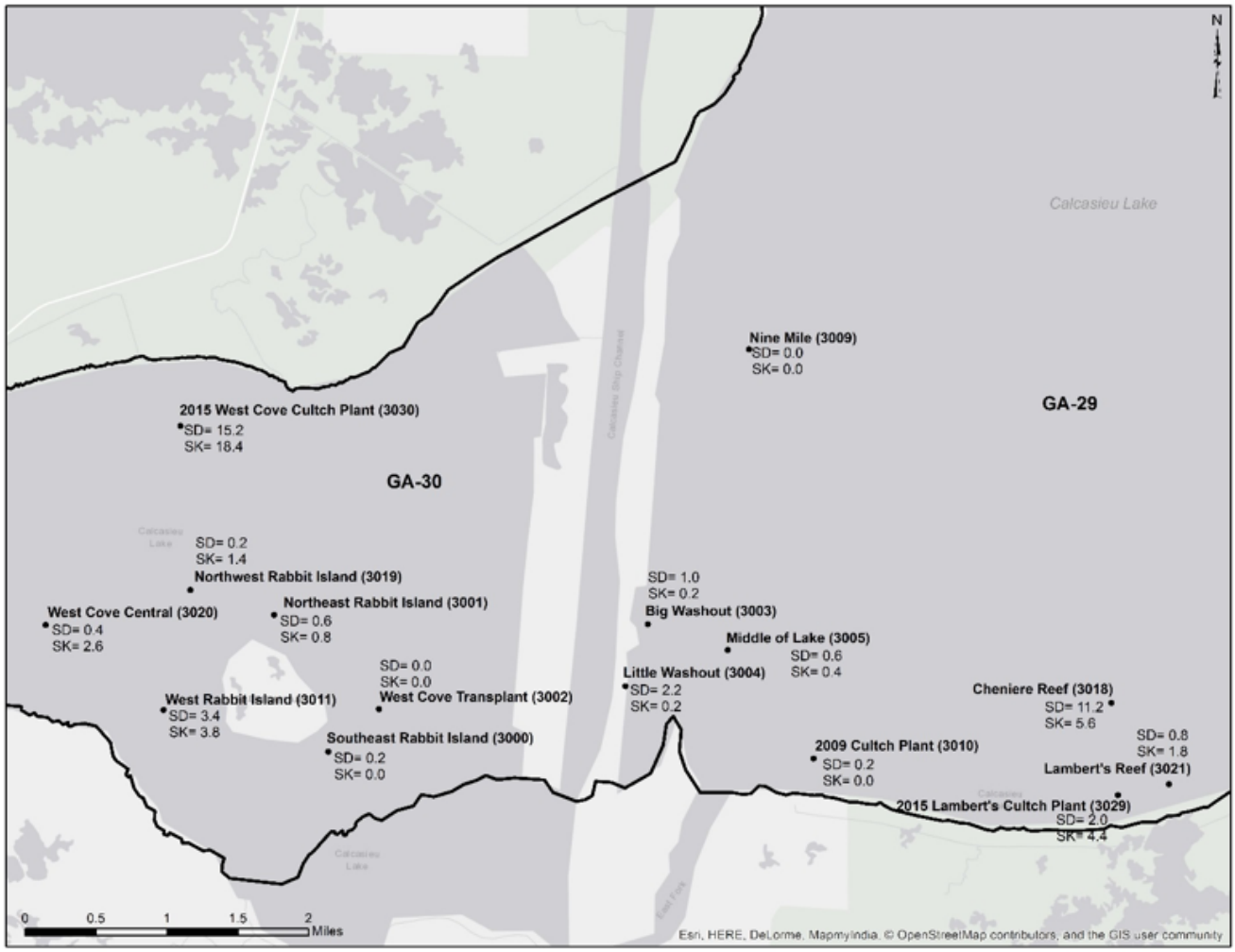

FIGURE 7.1. 2018 Coastal Study Area 7 oyster stock assessment sampling stations in Calcasieu Lake.

Methods

Traditional Sampling

LDWF biologists collected field samples for the 2018 oyster stock assessment on July 2, 2018 from 15 sampling stations in CSA 7 according to the methodology described in the Statewide Overview of this report (*Figure 7.1*). One sampling station was established at each cultch plant to characterize the oyster productivity on these areas.

As there are no bedding (seeding) operations in Calcasieu and Sabine lakes, and all harvest is for direct market, biologists report the data collected in sacks of market-size oysters rather than in bbls, the standard unit of measure used for oysters in other parts of coastal Louisiana. For market-size oysters, 180 oysters equals one sack. Two sacks equal one bbl.

Cultch Plant Sampling

In December 2017, a 150-acre cultch plant was built near Long Point to provide additional bottom habitat and increase production of oyster resources in Calcasieu Lake. LDWF assesses newly constructed cultch plantings by collecting quarter-square-meter samples at randomly selected points within the area. A total of five sampling stations were chosen at random for each cultch plant area and a single sample was collected at each station.

Results and Discussion

Seed and Market-Size Stock

The 2018 oyster stock assessment estimated that the current oyster stock in Calcasieu Lake was approximately 162,491 sacks of market-size oysters and 60,917 sacks of seed oysters (*Table 7.1*). As in previous years, the majority of Calcasieu Lake's market-size oysters were located in West Cove (GA-30).

There was a 63.7 percent increase in market-size oysters in GA-29 from 2017 to 2018 (*Figure 7.3*). The population was 86.4 percent below the long-term average for this area. The majority of stock was found at cultch plant locations and natural reefs near Lambert's Bayou.

There was continued increase in numbers of market-size oysters in GA-30 from 2017 to 2018. The estimated population increased 55.1 percent from 2017. This marked the second year in a row that market-size oysters increased in West Cove, and the population of oysters in this area was approaching the long-term average (*Figure 7.4*).

Recruitment

LDWF biologists continue to be concerned about the decline of seed oysters and a lack of significant recruitment in the traditional reef areas in Calcasieu Lake. According to the 2018 oyster stock assessment, the amount of available seed oysters in GA-29

increased 28.1 percent compared to the 2017 estimate (*Figure 7.3*). There was also an upward trend in seed oysters in GA-30. The 2018 oyster stock assessment estimated seed oysters in West Cove increased 38.1 percent from 2017. However, even with the yearly increases in GA-29 and GA-30, both areas remain 75 percent below the long-term average (2008-2018) .

Hydrological Data

Average water temperatures recorded during dredge samples for Calcasieu Lake in May and June 2018 were 27.2 and 29.4°C, respectively. These temperatures were slightly above the long-term averages for these months (*Figure 7.5*). The average water temperature during the 2018 oyster assessment was 30.2°C, nearly equal to that of the long-term average temperature of 29.9°C.

Average salinities recorded during dredge samples for Calcasieu Lake in May and June 2018 were 16.4 and 18.0 ppt, respectively. May's average salinity levels were slightly higher than the May long-term average of 15.0 ppt (*Figure 7.5*). June's average salinity levels were higher than the June long-term average. The average salinity recording during 2018 oyster stock assessment sampling (July 2018) was 18.3 ppt, higher than the long-term average of 17.2 ppt. Lower than normal rainfall during the spring and early summer caused salinity levels in the lake to become more elevated than normal.

Tropical and Climatic Events

Hurricane Harvey made initial landfall near Rockport, Texas on Aug. 26, 2017 as a Category 4 hurricane, stalling in the area for a couple of days. After moving back out into the Gulf of Mexico, Harvey made a second landfall as a tropical storm near Cameron, Louisiana, on Aug. 30, 2017. The highest storm surge was 12.5 feet in Aransas County, Texas. Some areas received 40-plus inches of rain, with 60.5 inches of rainfall in Nederland, Texas, and 26 inches of rain in 24 hours in Port Arthur, Texas, resulting in freshwater input in Sabine Lake and some in Calcasieu Lake.

2017/2018 Oyster Season

The Commission opened GA-30 to harvest beginning Nov. 1, 2017, with a daily sack limit of seven sacks per day (*Table 7.2*). GA-29 was closed to harvest because of low numbers of available market-size oysters.

The recently enacted legislation to prohibit the use of mechanical scrapers in Calcasieu Lake had a significant impact on commercial oyster harvest effort and consequently landings this past season. Based on LDWF trip ticket data, approximately 14 boats per day were actively harvesting oysters in Calcasieu Lake during the open days of the 2017/2018 season, a 65 percent reduction from 40 boats per day during the previous season. This reduction in effort directly impacted commercial landings of oysters in Calcasieu Lake. LDWF

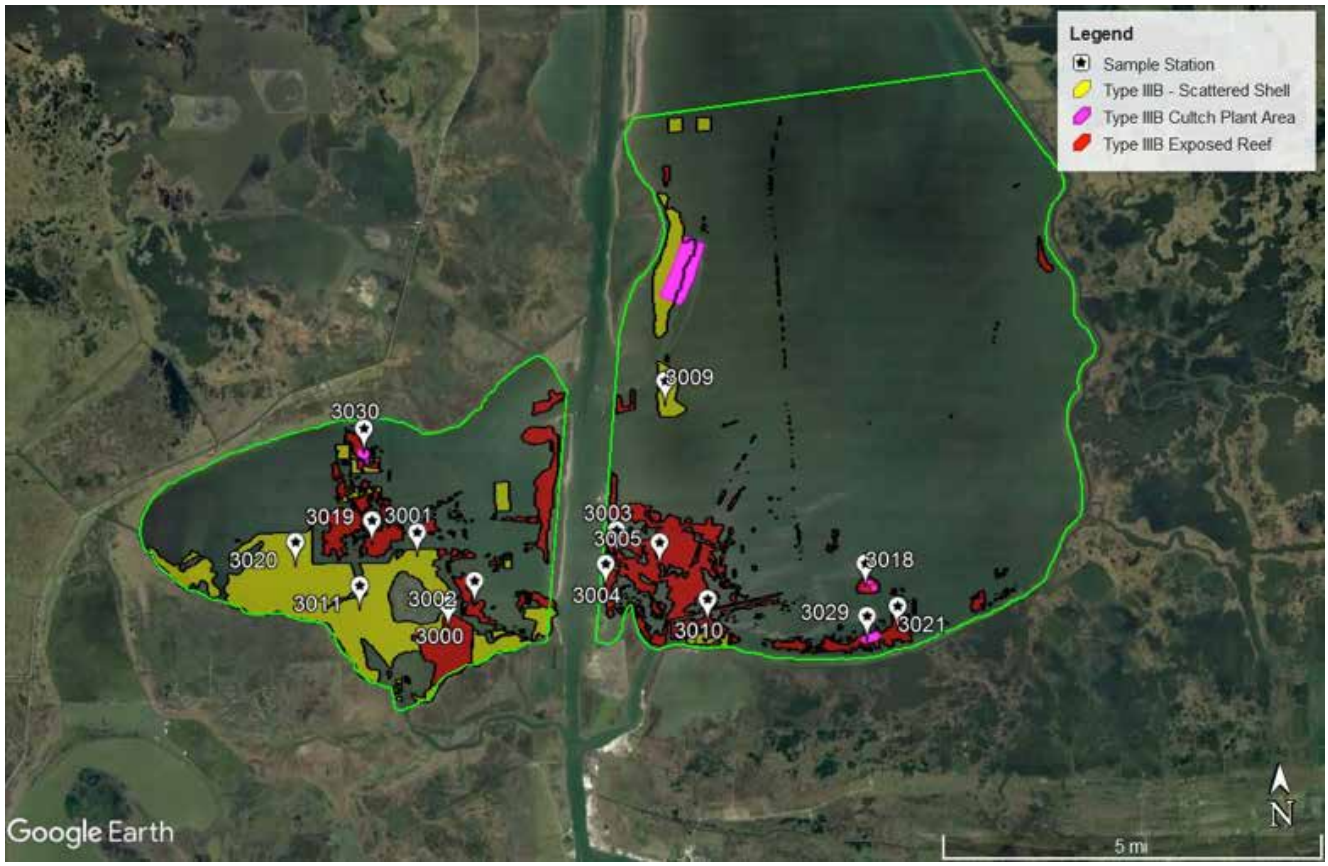

FIGURE 7.2. Estimated high quality oyster habitat (Bottom type IIIB) coverage as delineated by side-scan sonar water bottom studies in Calcasieu Lake.

trip ticket data indicate 8,387 sacks of market-size oysters were landed during the 2017/2018 season (*Figure 7.6*), a 58.8 percent reduction over the previous season's report of 20,334 sacks landed in both growing areas combined. When considering West Cove only, there was only a 33.6 percent reduction from the previous year's estimated harvest of 12,638 sacks.

The number of closures to oyster harvesting in Calcasieu Lake due to LDH health concerns was typical of a normal oyster season with 66 percent of the total oyster season open to harvest in GA-30 (*Table 7.2*).

Comparing LDWF trip ticket data with results from the 2017 stock assessment, approximately 9.0 percent of the standing crop of market-size oysters in GA-30 was harvested in the 2017-2018 season (*Figure 7.6*).

TABLE 7.1. 2018 estimated oyster availability on Growing Area (GA)-29 and GA-30 in Calcasieu Lake.

Public Oyster Area	Sacks of Spat Oysters	Sacks of Seed Oysters	Sacks of Market-Size Oysters
West Cove (GA-30)	56	43,270	144,101
Eastside (GA-29)	714	17,647	18,390
Total Harvest Area	**770**	**60,917**	**162,491**
Seed/Market-Size Total (Sacks)			***223,407***

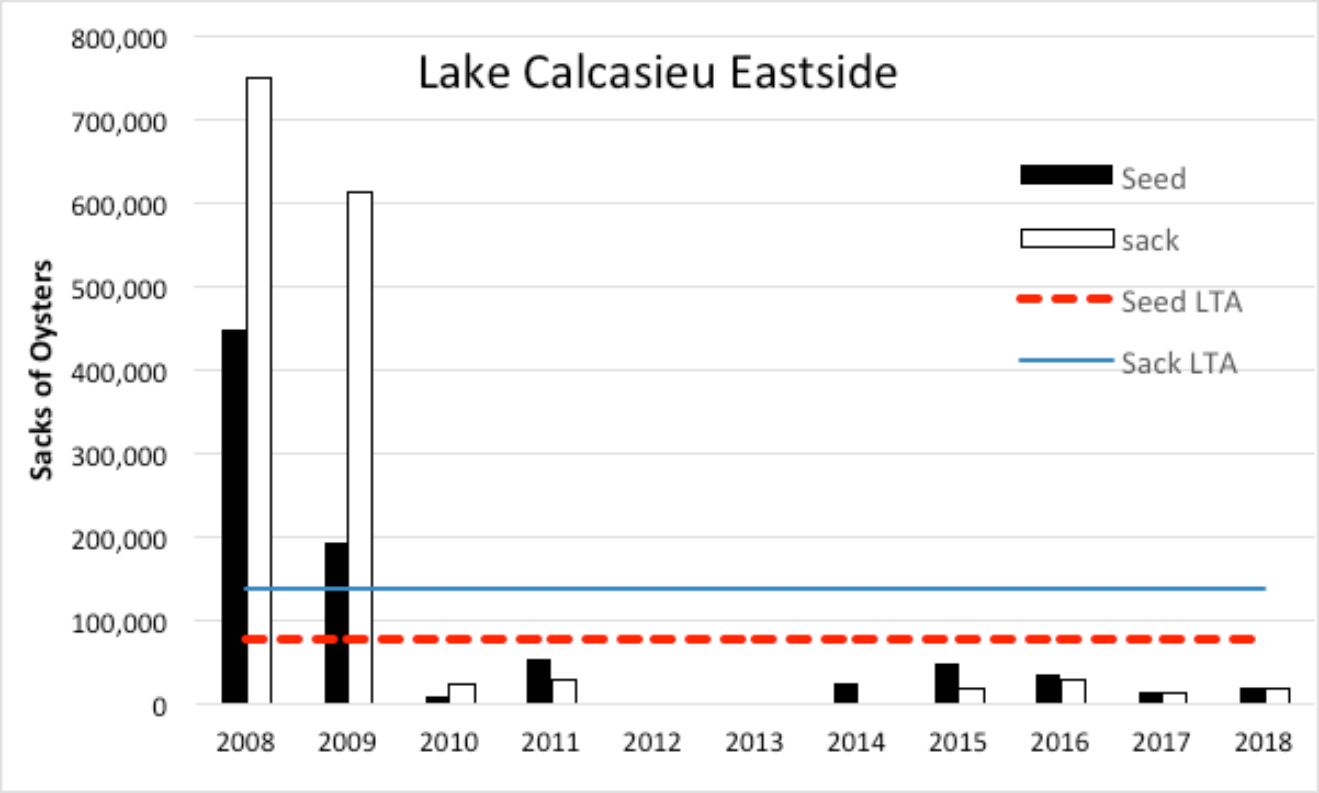

FIGURE 7.3. Seed and market-size oyster numbers estimated during annual stock assessment monitoring in Growing Area (GA)-29 (Eastside), Calcasieu Lake, Cameron Parish, Louisiana.

TABLE 7.2. Public oyster season and number of days open to harvest as a percentage for Growing Area (GA)-29 and GA-30 in Calcasieu Lake.

Season		Season Dates	Total Days	Eastside		West Cove	
				Days Open	% Open	Days Open	% Open
1996-97		Oct. 16 - April 30	197	149	76	114	58
1997-98		Oct. 16 - April 30	197	139	71	96	49
1998-99		Oct. 16 - April 30	197	135	69	120	61
1999-00		Oct. 16 - April 30	197	197	100	182	92
2000-01		Oct. 15 - April 30	198	180	91	106	54
2001-02		Oct. 15 - April 30	198	158	80	61	31
2002-03		Oct. 15 - April 30	198	146	74	66	33
2003-04		Oct. 15 - April 30	199	172	86	126	63
2004-05		Oct. 15 - April 30	198	168	85	68	34
2005-06[1]	**GA-29**	Oct. 15 - April 30	198	187	94		
	GA-30	Oct. 8 - April 30	205			165	80
2006-07	**GA-29**	Nov. 1 - April 30	181	118	65		
	GA-30	Oct. 16 - April 30	197			70	36
2007-08	**GA-29**	Nov. 1 - April 30	182	165	91		
	GA-30	Oct. 15 - April 30	199			131	66
2008-09	**GA-29**	Oct. 15 - April 30	198	183	92		
	GA-30					125	63
2009-10	**GA-29**	Oct. 15 - April 30	198	157	79		
	GA-30					80	40
2010-11[2]	**GA-29**	Nov. 15 - March 25[4]	131	131	100		
	GA-30[3]	Oct. 15 - April 30	198			186	94
2011-12[5]	**GA-29[6]**	Closed	-	0	-		
	GA-30	Nov. 1 - April 30	182			92	51
2012-13	**GA-29**	Closed	Closed	0	-		
	GA-30	Nov. 1 - April 30	181			82	45
2013-14	**GA-29**	Closed	Closed	0	-		
	GA-30[7]	Nov. 1 - April 30	181			158	87
2014-15	**GA-29**	Closed	Closed	0	-		
	GA-30	Oct. 26 - April 30	187			111	59
2015-16	**GA-29**	Closed	Closed	0	-		
	GA-30	Nov. 1 - April 30	182			108	59
2016-17	**GA-29**	Nov. 1 - Feb. 13	105	86	82		
	GA-30	Nov. 1 - Jan. 24	85			54	64
2017-18	**GA-29**	Closed	Closed	0	-		
	GA-30	Nov. 1 - May 15	196			130	66

[1]As of the 2005/2006 season, the lake was divided into two conditional managed areas, which were managed separately and may have different seasons.
[2]As of the 2010/2011 season, conditional managed areas were changed to growing areas (GA).
[3]From Oct. 15 - Nov. 14, the daily sack limit in GA-30 was 20. Daily limit was 10 for the remainder of the year.
[4]GA-29 closed due to heavy pressure on the resource; see Louisiana Department of Wildlife and Fisheries (LDWF) news release from March 22, 2011.
[5] 2011/2012 oyster harvesting on Calcasieu Lake was by special permit only; see LDWF news releases from July 7, 2011 and Sept. 15, 2011.
[6]GA-29 was closed; see LDWF news release from Sept. 1, 2011.
[7]Louisiana Department of Health closure threshold changed from 7.0 to 9.0 feet at Kinder gauge.

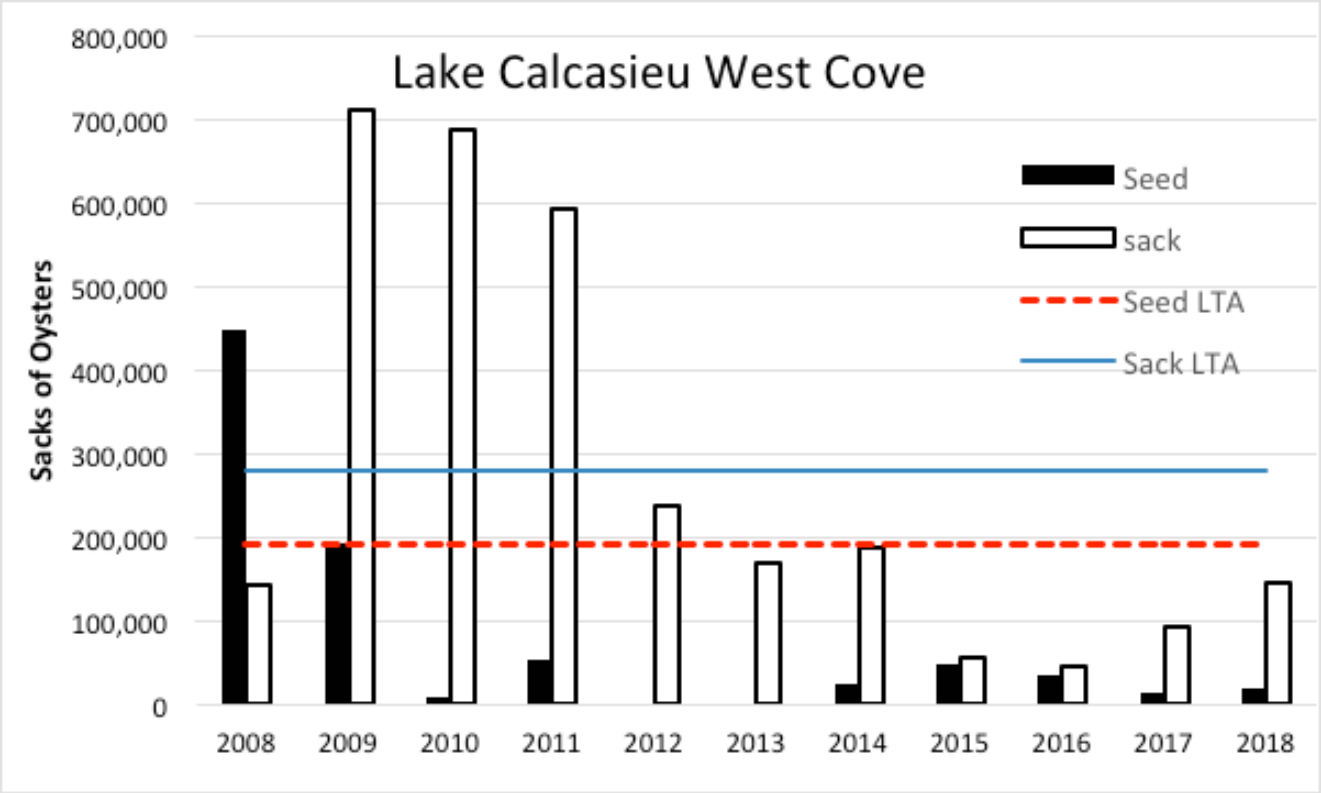

FIGURE 7.4. Seed and market-size oyster numbers estimated during annual stock assessment monitoring in Growing Area (GA)-30 (West Cove), Calcasieu Lake, Cameron Parish, Louisiana.

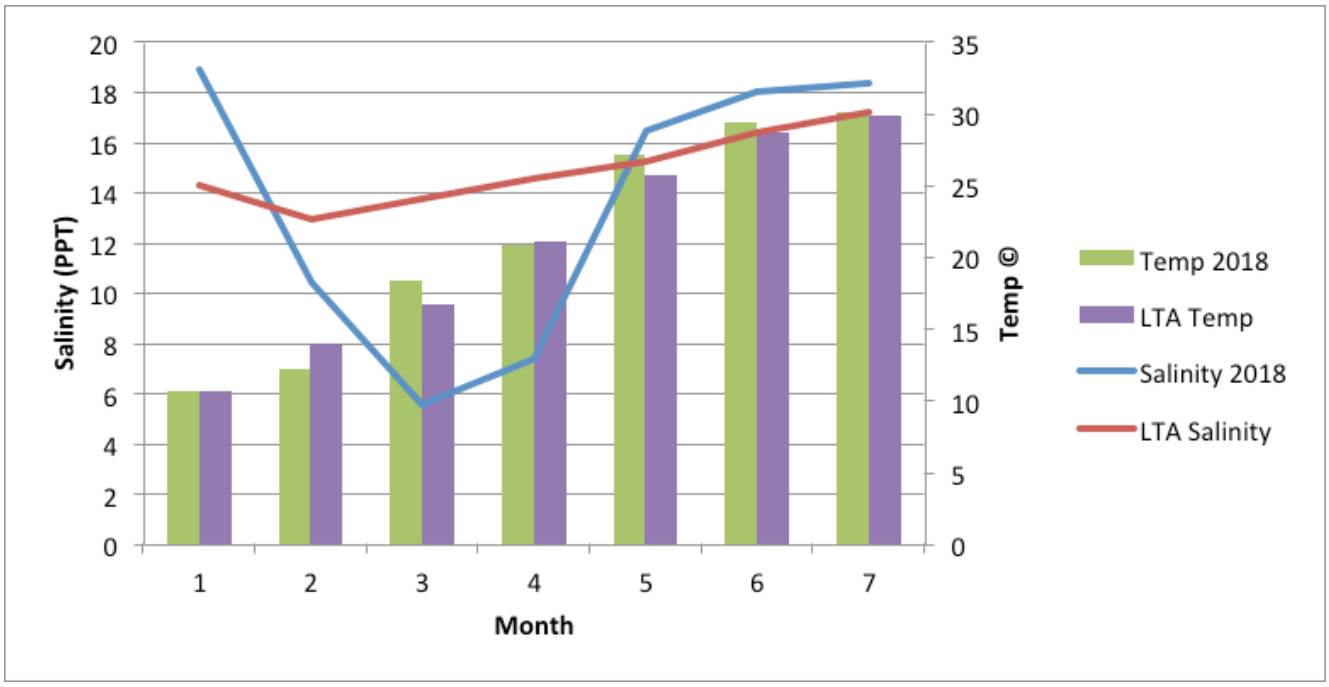

FIGURE 7.5. Salinity and temperature levels recorded during dredge and square-meter samples of the Calcasieu Lake public oyster areas in 2018.

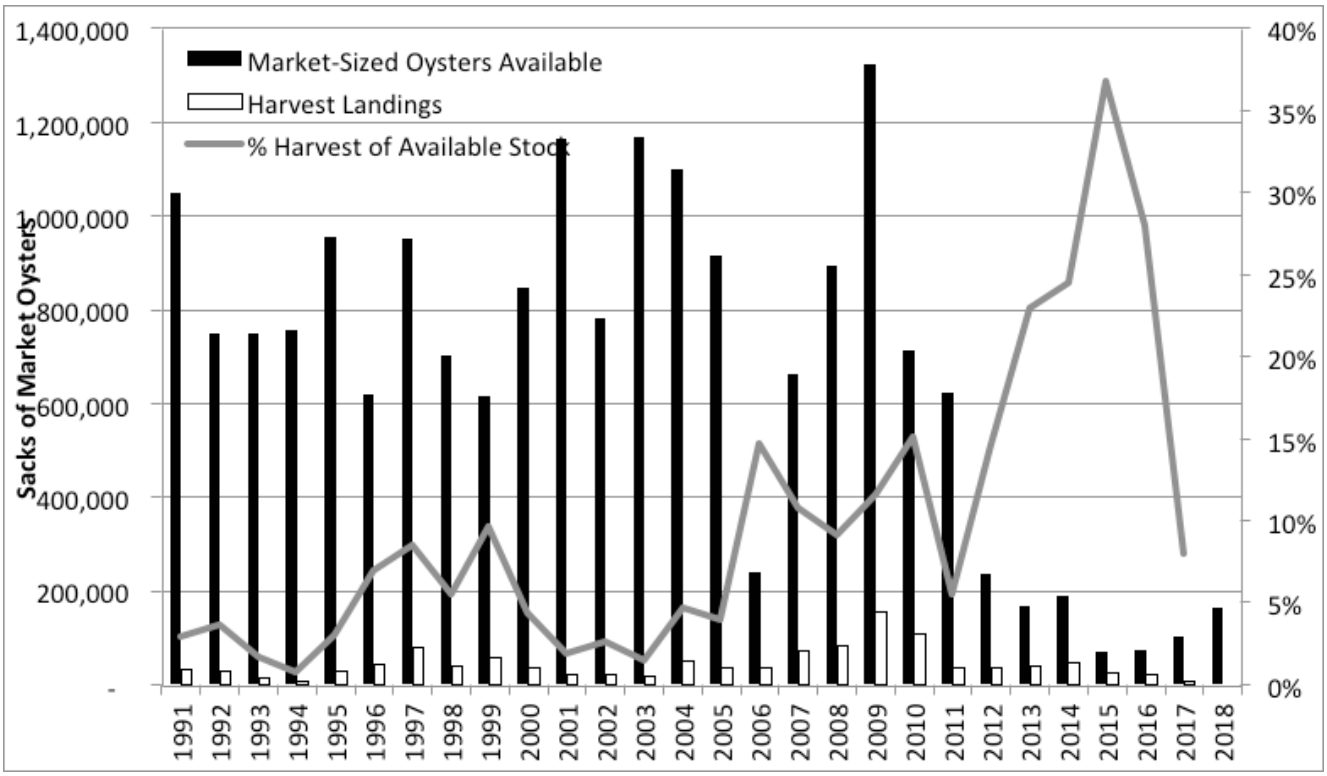

FIGURE 7.6. Historical stock assessments and landings of oysters from public oyster areas of Calcasieu Lake.

APPENDIX I

Levels of the parasite *Perkinsus marinus* in sack and seed oysters: Louisiana Public Seed Grounds, 2018

by

Thomas M. Soniat, Ph.D.

24 August 2017

The parasite *Perkinsus marinus* is among the most significant causes of oyster mortality. It is responsible for annual mortality rates that exceed 50% in many populations of adult eastern oysters (*Crassostrea virginica*). Mackin et al. (1950) described P. marinus as *Dermocystidium marinum*, hence the common name "dermo" which is still in use today.

Dermo was discovered during investigations into the impact of oil and gas activities on the Louisiana oyster industry; these investigations were funded by a consortium of oil companies and directed by Texas A&M University (Mackin and Hopkins, 1962). Extensive studies focused on the effects of crude oil, bleed water, natural gas, drilling mud, and seismographic surveys revealed that none of these pollutants or activities explained the widespread mortalities of oysters that had been observed. Instead, dermo is the major cause of oyster mortality from Maine to Mexico (Soniat, 1996).

High water temperatures and high salinities favor the proliferation of dermo. Thus, infections are more intense in the late summer, on the seaward side of estuaries, and during droughts. Drought conditions on the Gulf Coast are associated with the La Niña phase of El Niño Southern Oscillation; however, increases in prevalence (percent infection, PI) precede sharp increases in intensity (weighted prevalence, WP), and epizootics of dermo in Louisiana can lag La Niña events by about 6 months (Soniat et al., 2005). Management techniques to minimize disease and increase oyster harvest include moving infected oysters to lower salinity, early harvest of infected populations, and even freshwater diversion into high-salinity estuaries. Because of the key role of dermo as a cause of oyster mortality, the success of oyster farming depends on the ability to manage oyster populations in the presence of high levels of disease (Soniat and Kortright, 1998).

The fluid thioglycollate method is the standard assay for determining the level of dermo parasitism (Ray, 1966). A small piece of oyster tissue is removed and assayed for disease after incubation in fluid thioglycollate and antibiotics for one week. Dermo intensity is scored using a 0-to-5 scale developed by Mackin (1962), where 0 is no infection and 5 is an infection in which the oyster tissue is almost entirely obscured by the parasite. PI and WP are calculated. WP is the sum of the disease code numbers divided by the total number of oysters in the sample). A WP of 1.5 could be considered a level at which disease-related mortalities are occurring (Mackin, 1962, Bushek et al., 2012). Mackin (1962) claims a population of live oyster with a WP of 2.0 "contains an intense epidemic, and more than half of the population may be in advanced stages of the disease, with all of the individuals infected".

Eighteen stations across coastal Louisiana were sampled for sack and seed oysters for the 2018 dermo study (*Table 1*). Samples were taken from:

- Grand Pass (GP), N.W. Jack Willliams Bay (JW), and Three Mile Pass (TM) in the Mississippi Sound area
- Drum Bay (DB) in the Breton Sound area
- Hackberry 2008 Cultch Plant (H8) in the Barataria system
- Lake Chien 2004 Cultch Plant (C4), Lake Chien 2009 Cultch Plant (C9), and the Lake Fortuna Cultch Plant (FC) in the Terrebonne Bay region
- Grand Pass (GR) and Sister Lake 218 (SL) in Sister Lake
- Buckskin Bayou (BB) and Rat Bayou (RB) in Bay Junop
- Nickle Reef (NR) and Lighthouse Point (LP) in the Vermilion Bay region
- Chenier Reef (CR) and West Rabbit Island (WR) in Lake Calcasieu
- Two stations (S2 and S3) in Sabine Lake.

There was an attempt to assay 10 market-sized (≥ 75 mm) oysters and 10 seed (25-74 mm) oysters from each site. However, in some cases insufficient numbers of oysters were available to satisfy that standard, more so in the case of seed oysters (Table 1).

The length of oysters was measured to the nearest mm. Anterior-ventral mantle tissue was removed from each oyster, incubated at room temperature in fluid thioglycollate for about a week, and assayed according to the standard Ray (1966) technique. The level of infection of oyster tissue by the parasite is reported as PI and WP.

PI and WP for seed and sack oysters are shown in Table 1. Where possible, direct reef-to-reef comparisons between results from 2018 and 2017 are made. (Note that samples in 2017 were collected in July, whereas samples in 2018 were taken in September.) Compared to 2017, the PI and WP of market oysters increased at GP in 2018; water salinity was also higher in this area in 2018. Salinity, PI, and WP at TM were higher in 2018 than in 2017. Market oysters from H8 showed a decrease in PI and WP in 2018 compared to 2017, even though salinity in 2018 was higher (15.1 vs. 1.2). Market oysters from C9 were uninfected in both 2017 and 2018, even though salinity was higher in 2018 (18.5 vs. 7.1). C4 samples showed in increase in PI, WP, and salinity compared to 2017 results. Market oysters from GR were uninfected in 2018 and lightly infected in 2017, even at lower salinity in 2017 (1.7 vs. 16.2). Market oysters from SL were uninfected in 2017 and 2018. Market oysters from BB were lightly infected in 2017 and 2018. Oysters from NR and LP were uninfected in 2017 and 2018. Reefs from Calcasieu Lake (CR, WR) and Sabine Lake (S1, S2) had higher salinities and higher levels of disease in 2018 than 2017; particularly evident was the increase in the percentage of oysters infected.

Overall, dermo levels and salinities were higher in 2018 than 2017, commensurate with the higher salinities measured during the study period. Complete records of disease levels from this year and previous years are available from Oyster Sentinel (*www.oystersentinel.org*). Particularly noteworthy is the marked increase in the percentage of oysters infected in Lake Calcasieu and Sabine Lake. However, none of the statewide samples collected in 2018 showed WP values that would suggest significant mortalities due to dermo (Mackin 1962, Bushek et al. 2012).

TABLE 1. Percent Infection (PI) and Weighted Prevalence (WP) of seed and market-size (sack) oysters from Louisiana Public Seed Grounds, 2018. Date is collection date, CP = Cultch Plant, T = temperature, S = salinity, NS = number of seed oysters assayed, NM = number of market oysters assayed. No data indicates insufficient numbers of oysters were collected.

Station	Date	T (°C)	S (ppt)	Seed PI	Seed WP	NS	Market PI	Market WP	NM
Grand Pass (CSA 1N)	9/10/18	28.9	25.2	No data	No data	0	75	0.30	4
N.W. Jack Williams Bay	9/10/18	29.8	25.6	20	0.07	10	30	0.20	10
Three Mile Pass	9/10/18	29.9	23.8	10	0.03	10	20	0.06	10
Drum Bay	9/14/18	28.8	9.8	0	0	10	50	0.70	10
Hackberry 2008 CP	9/10/18	29.3	15.1	20	0.06	10	10	0.07	10
Lake Chien 2004 CP	9/10/18	30.3	19.1	No data	No data	0	20	0.5	10
Lake Chien 2009 CP	9/10/18	29.8	18.5	No data	No data	0	0	0	10
Lake Fortuna CP	9/17/18	31.5	13.9	No data	No data	0	10	0.03	10
Grand Pass (CSA 5W)	9/10/18	30.1	16.2	No data	No data	0	0	0	10
Sister Lake 218	9/10/18	30.6	18.9	0	0	10	0	0	10
Buckskin Bayou	9/10/18	28.8	9.8	No data	No data	0	10	0.03	10
Rat Bayou	9/10/18	29.9	18.5	No data	No data	0	10	0.03	10
Nickle Reef	9/10/18	29.0	17.3	0	0	10	0	0	10
Lighthouse Point	9/10/18	29.7	9.7	0	0	10	0	0	10
Chenier Reef	9/12/18	27.0	23.9	50	0.30	10	70	0.27	10
W. Rabbit Island	9/12/18	26.4	20.7	30	0.20	10	60	0.53	10
Sabine Lake 2	9/12/18	27.9	16.4	10	0.03	10	50	0.20	10
Sabine Lake 3	9/12/18	26.4	20.7	44	0.44	9	50	0.47	10

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